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Cape York Pad-tail gecko *(Pseudothecadactylus australis)* from Cape Weymouth, Cape York Peninsula. See paper on page 48 (photo: R. Valentic).

Eastern Snake-necked turtle *(Chelodina longicollis)* from Boort, Victoria. See paper on page 46 (photo: D. Green)

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HERPETOLOGICAL NOTES

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SOME OBSERVATIONS ON REPRODUCTION AND BEHAVIOUR IN THE BARDICK *ECHIOPSIS CURTA* (SCHLEGEL, 1837) (SERPENTES: ELAPIDAE)

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E.curta has three disjunct populations found in southern Western Australia, Eyre Peninsula and the mallee area of south-eastern South Australia, south-western New South Wales and Western Victoria (Longmore, 1986; Ehmann, 1992). The eastern population is considered under threat (Cogger *et al*, 1993) and the species is listed as 'vulnerable and rare' on the 1992 Revised Schedule 12 of the NSW Endangered Fauna (Interim Protection) Act 1991. Little is known about its habits although it is said to be nocturnal (Cogger *et al*, 1992) or partly nocturnal (Worrell, 1963) and viviparous (Shine, 1982). The average size of adults is about 30 cm with a maximum of 60 cm (Shine, 1982). The venom is said to have affinities with that of the Death Adders and the snake is described as being 'DANGEROUS' (Cogger, 1992) although Glauert (1957) states that it is '...not at all dangerous to man.' The diet includes frogs, agamids, skinks, geckos, birds and mammals (Ehmann, 1992), also insects (Glauert, 1957; Shine, 1982). Slight morphological, colour and behavioural variations between the populations indicate the need for more detailed taxonomic evaluation. This is the first detailed account of a litter of Bardicks born in captivity.

While searching for geckos about 6:30 pm on 10 January 1994, a group of herpetologists including the author found a gravid female Bardick (total length 414 mm (363+51mm), mass 54.4g), in an area of open low scrub under a small pile of brush on flat, dry, loose, sandy soil about 65 km SW of Whyalla (33°23'S, 137°4'E). The region has suffered considerably from bush fires and massive clearing in recent years. The air temperature was about 26°C. The fact that the snake was visible through the brush may indicate that it was basking in the filtered sunlight and that the species may not be totally nocturnal. Another possibility is that the female was basking because it was gravid. An adult *Suta spectabilis* was also under the same pile of brush.

In captivity the snake was maintained in a 600 mm glass terrarium with a loose sand substrate. Bark, leaf litter, a rock, a cardboard hide, and a petri dish for water were provided. The temperature was maintained at 26 ± 4°C, a 40 watt fluorescent top light provided a constant photoperiod of 12 hours and a 60 watt lamp was placed under the supporting bench near one corner giving a slight temperature gradient.

When first captured the snake was very aggressive, rearing up with rapid jerky movements and striking at almost anything that moved nearby. Gow (1976) also comments on the aggressive nature of this species. When first put in a bag it bit through the cloth, producing sufficient venom to run down the outside of the bag. It gradually calmed down over a period of about a week when it stopped rearing up and striking at a finger moved near the glass.

It was monitored until it gave birth early on 3 March 1994 to six young and two undeveloped embryonic sacs. Shine (1982) gives the range of litter sizes as 3-14, ($\bar{x}$ = 7.1, N = 23). Shine also found the largest ovarian follicles occurred in October and January with oviducal embryos being found in November, January and February suggesting that births would occur in late summer.

The births were not witnessed but occurred between 11:00 pm and 7:00 am. Apart from some restlessness there was no other observed change in behaviour prior to this, although it spent most of the time curled up in

the warmest corner of the terrarium rather than in the hide or under the leaf litter.

The adult female weighed 36.7g after the births. It had 19 mid-body scale rows, 137 ventrals, undivided anal, 28 subcaudals, all undivided except the first and a conical terminal scale about twice the length of the preceding subcaudals. The head scalation was normal except that the frontal scale was long and narrow and divided transversely into two scales. Also a small 'interparietal' scale was present. The colour was light brown above and yellowish, grey-brown below. The upper labials and sides of the head had several small rather obscure cream marks and there were some dark markings under the chin.

The neonates were all semi-gloss, very dark brown almost black above, uniform grey below and there were vague small pale spots on the upper lips. The average total length (measured against a ruler) was 144 mm and ranged from 137 mm (117+20) to 156 mm (137+19). The average neonatal mass was 2.39g and ranged from 2.28g to 2.55g. This gives a moderately large relative clutch mass (RCM) of 39.1% of maternal post-parturition wet mass (excluding mass of undeveloped embryos, membranes etc.). Shine (1982) suggests that this species may have a very high RCM correlated with maternal size but this particular clutch was well below that expected from the formula calculated from the dissected museum specimens examined by Shine. The average tail length was 16.2% of snout-vent length and ranged from 13.9% to 17.6%, the adult having a tail 14.0% of snout-vent length.

The fact that % tail lengths fell into two groups 13.9-14.8% (n=3) and 16.8-17.6 (n=4) may indicate a sexual dimorphism. Shine (1982) found that the average sizes of adult males and females were similar although males matured earlier and females tended to grow slightly larger. The number of subcaudals averaged 31 ranging from 28 to 34. These were distributed as 32-34 in the presumed males (longer tails) and 28-30 in the adult and presumed female hatchlings (shorter tails). The presumed males had snout-vent lengths ranging from 117-125 mm whereas the two presumed females had snout-vent lengths of 128 and 137 mm. The number of enlarged ventrals ranged from 132-147, average 137 with the adult and presumed females having 137-147 ventrals and the presumed males having 132-136 ventrals. All seven specimens had 19 mid-body scale rows, the paraventrals being about twice as wide as the vertebrals. All seven specimens had distinctive anomalies of scalation. One having a 'loreal' scale, one having three post-oculars, one having a frontal divided into three scales, another into two scales, two had a small 'interparietal' scale, one had a divided parietal on each side, one had a small interstitial labial scale, three had a sinuous or interrupted interparietal groove and one had a pre-ocular not in contact with the nasal scale. Most had more than one scalation anomaly but all appeared active and healthy.

The position of the umbilicus varied from 13 to 18 scales anterior to the vent and involved from 2 to 4 scales being completely divided and with an additional 2 to 4 scales with a distinct mid-line crease. The adult female showed almost no sign of the umbilical scar indicating that even completely divided scales can eventually heal to form a normal complete ventral scale.

All six neonates evacuated their cloacae on being handled for measurement (after weighing). The excretion consisted of clear watery fluid with no evidence of white uric acid precipitate being present, indicating that the nitrogenous wastes had been excreted via the maternal circulation. For comparison the hatchlings of several oviparous reptile species have been observed to excrete insoluble uric acid together with a clear fluid under similar circumstances.

The neonates were housed in a 600 mm by 400 mm vivarium at room temperature (26 ± 3°C). The first sloughs occurred between 39 and 42 days and feeding on hatchling *Lucasium damaeum* began 73 days after

hatching. At sloughing the colour changed to matt grey/brown. Although active, the young were much less aggressive than the adult. They readily climbed rocks and vegetation in the terrarium and were often found tangled together or in proximity under a piece of bark or occasionally basking under the lamp. At 90 days one hatchling had still not fed, its weight had reduced 11.7% to 2.02g but its overall length had increased 7.9% from 140 to 151 mm indicating use of energy reserves for growth as well as metabolism during this fasting period. One hatchling aged 80 days was observed to drink from the edge of a water container. The snout was touching the side of the container just above the water surface. The tongue was not observed to be protruded but gular pumping at a rate of about one per second continued for several minutes presumably drawing in water.

Initially small frogs, scorpions and skinks were steadfastly refused as food by the adult snake but the gecko *Diplodactylus damaeus*, which is common around the site of capture, was readily taken. No feeding occurred in the last two weeks prior to giving birth. After giving birth the adult snake readily fed on various live geckos (*Diplodactylus*, *Lucasium* and *Oedura* spp.) and large brown moths (Hepialidae, *Fraus* sp? with a magenta tinge on anterior dorsal surface). These were pounced upon as they moved across the substrate. Small frogs *(Crinia signifera)* were eaten with some reticence but small live skinks (*Lampropholis* spp.) were steadfastly refused in spite of being almost continually present, except for a single *Lampropholis delicata* eaten about five months after capture.

A complete slough was produced by the female 64 days after giving birth. The slough measured 533 mm (468+65) mm which shows a stretch of about 47%. The maximum ventral scale width was 17.5 mm, both of these measurements are useful in estimating the size of original specimens when sloughs are found in the wild.

A herpetologist who got too close to the snake was bitten on the hand (just after the snake had been fed) but suffered no clinical effects apart from a headache, which may well have been psychogenic or due to other causes.

From a conservation perspective it is important to obtain and record basic information on all Australian herpetofauna if optimum strategies for conservation and legislation are to be implemented. It is not difficult for amateurs to obtain useful information with only a minimum of equipment provided they are prepared to make use of opportunities as they arise. Opportunistic herpetology can and should make a major contribution to the understanding of Australian frogs and reptiles.

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NOTES ON THE MOURNING GECKO *LEPIDODACTYLUS LUGUBRIS* IN THE DAINTREE REGION.

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The Mourning gecko, *Lepidodactylus lugubris*, is a small, arboreal, parthenogenetic gecko with a disjunct cosmopolitan distribution (Mau 1978, McCoy 1980, Zug 1991). This species, along with House gecko, *Hemidactylus frenatus*, has been inadvertently introduced to many tropical Pacific Islands (including Australia) through human activities in this region (McCoy 1980, Zug 1991, Bolger & Case 1992, Case et al. 1994). In Australia the distribution of *L.lugubris* is confined to several coastal localities in far north Queensland (Innisfail to Daintree, Weipa and Cape York peninsula; Wilson & Knowles 1988, Cameron & Cogger 1992). *L.lugubris* is frequently associated with areas of human habitation such as urban or suburban environments, though not exclusively (Case et al. 1994).

We present observations on *L.lugubris* from the Daintree region (16° 29'S, 145° 20'E) of far north Queensland (approx. 100km north of Cairns). These observations were made on a three day visit to the area from the 7-10th March 1994 and were largely confined to the Daintree township. Weather conditions during the visit were warm and humid with daily maximum temperatures between 28-33°C while night temperatures did not fall below 23°C. Early morning mist rains occurred but there was no precipitation and the area was generally quite dry.

OBSERVATIONS

General Habits

A total of 34 *L.lugubris* were observed. Of these, 16 were captured and their snout-to-vent length (SVL) and total length (TL; for lizards with original tails) were measured and the ranges were SVL = 36-40mm and TL = 84-90mm. The SVL range lies within the adult SVL range given by Zug (1991). The sizes of those lizards not captured appeared also to lie in this range. No juveniles were observed.

L.lugubris were very common in and around human dwellings, particularly near outdoor artificial lights at night where they were readily observed feeding on mosquitoes and small moths. Often two or three individuals would gather around a single light and feed alongside *H.frenatus* and *Litoria rubella*. No interactions were observed among or between species in the gatherings.

While *L.lugubris* were active and easily located at night, on two occasions individuals were observed moving around during daylight hours in partly shaded open situations. It was not clear whether they were foraging or moving from one retreat to another. Typically, individuals became active at dusk (earliest time recorded was 6:15pm, EST) and continued their activity through until at least 1am.

Reproduction

Of the 34 *L.lugubris* observed, 14 were clearly gravid. The translucent ventral surface of these lizards admitted a clear view of enlarged ova and eggs. When lizards were viewed dorsally eggs were clearly discernible as large bulges protruding from the abdominal wall. All the gravid females observed contained two eggs. Furthermore single pairs of eggs were recorded at four sites frequented by *L.lugubris*.

A total of 26 eggs were located. Freshly deposited eggs were nearly spherical in shape with an adhesive clean white shell. The contents of eggs as viewed through the shell was pale orange. Freshly deposited eggs

measured approximately 8 X 7mm (n=4) (cf. Chapter 3, Table 8, Greer 1989). Only two of the eggs were empty. It was not clear whether these had hatched or had been preyed upon. Eggs were generally deposited in day-shaded, partly or completely open, arboreal sites around human dwellings (e.g., walls, ceilings, roofing etc.). No eggs were observed in sites exposed to direct sunlight or near artificial lights where nightly gatherings occurred. One of the more peculiar nest sites was inside the aluminium frame of a fly-wire window screen. Two eggs and a non-gravid adult *L.lugubris* were clearly visible at the entrance of a small aperture in the frame.

Communal Egg-laying Sites

Two small communal egg-laying sites were located on the underside of a 4m x 4m corrugated fiber-glass roof construction on the banks of the Daintree River. One clump was located near the top of a 3m treated timber support and consisted of three pairs of eggs. Eggs comprising the pairs were often touching while the distance between the pairs was 1-2cm. The second clump was located in a rounded corner of fiber-glass roofing some 40cm up from the first and consisted eight eggs also deposited in pairs. There was a gravid female *L.lugubris* carrying two eggs lying over part of the clump. A second gravid female was observed near the apex of the roof structure some 3m away. She was observed making her way over to the corner where the first female was lying with the egg clump.

The sites were re-examined the following evening. A new pair of eggs had been deposited at the second clump, for a total of ten eggs. Again there was a gravid female lying at the edge of the clump. It was not possible to say whether this was the same female. She was not present at the egg clump during daylight hours. In total, nearly two-thirds (n = 16) of all the eggs located belonged to these two clumps- the remainder were deposited as separate pairs.

DISCUSSION

Communal egg-laying has been recorded in *L.lugubris* inhabiting the Solomon Islands, Fiji, Cocos Islands and Guam (Wood-Jones 1909, McCoy 1980, Cogger et al. 1983, Zug 1991, McCoid 1994). Wood-Jones (1909) recorded clusters of 4 and 6 eggs. *L.lugubris* are clearly not strict communal egg-layers as indicated by the occurrence of single clutches of eggs and this trend is also seen in several species of *Gehyra* (see Greer 1989, Ehmann 1992).

Daytime movements in *L.lugubris* have previously been recorded by Wilson & Knowles (1988) who comment that the species is often observed foraging by day in sheltered positions or basking in weak sunlight.

Our observation that the *L.lugubris* population consisted of a single adult size class has several possible explanations. One explanation is that adult size is attained within 12 months, otherwise one would expect to see multiple, distinct, size classes or a continuous size distribution. This explanation requires that reproduction does not occur continuously throughout the year. Another explanation is that immature *L.lugubris* (i.e., eggs and juveniles) are subject to high levels of predation. These explanations are not mutually exclusive and there is evidence for both which we describe below.

Mau (1978) recorded that maturity in *L.lugubris* can be attained as early as 8 1/2 months of age in captivity. This is consistent with the first explanation. However several authors have recorded reproduction in *L.lugubris* to be aseasonal. Cogger *et al.* (1983) recorded egg-deposition in Cocos Island populations during April-May and state that it is likely that reproduction occurs throughout the year. In support of this was their observation that no clear divisions existed between age (=size?) classes. Cameron & Cogger (1992) comment that reproduction in populations of *L.lugubris* inhabiting the Weipa region may also be aseasonal. Zug (1991) recorded females with shelled oviductal eggs in April, September, November and December

at various locations in Fiji. It is possible that at a given locality reproduction in *L. lugubris* is concentrated at a particular time of year but that the timing differs markedly between localities.

The alternative explanation is supported by the observation that adult *H. frenatus* are predators of juvenile *L. lugubris*.

Bolger & Case (1992) conducted laboratory tests on interspecific interference between *L.lugubris* and *H.frenatus* that demonstrated a clear asymmetry in this ability in favour of *H.frenatus*. Case et al. (1994) hypothesized that the dominance of *H.frenatus* was likely, under certain circumstances, to lead to the competitive exclusion of *L.lugubris* and presented evidence indicating that such exclusions have occurred on a number of Pacific islands. In its extreme, this dominance took the form of predation in which juvenile *L.lugubris* were consumed by adult *H.frenatus* (Bolger & Case 1992). This behavior has been observed in the field (Tim Hawkes, pers.comm.). To what extent it affects recruitment in *L.lugubris* populations has not been determined.

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HERPETOFAUNA OF DIRK HARTOG ISLAND SHARK BAY AREA, WESTERN AUSTRALIA

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ABSTRACT

An annotated list is presented for the one frog and 37 species and subspecies of terrestrial reptiles recorded from Dirk Hartog Island, the western most land point of Australia.

INTRODUCTION

The Shark Bay area on the mid-west coast of Western Australia has an incredibly diverse herpetofauna with 118 species and subspecies recorded (Storr and Harold 1990). This area includes a number of islands that are generally small in size, the largest is Dirk Hartog which lies between latitudes 25°30' and 26°15'S and is approximately 79 km long by 11 km wide with an area of 62,000 ha.

In the past 15 years several herpetological surveys have been undertaken in the Shark Bay area. Data on the local distribution, habitat preferences and abundance of many species is known from Storr and Harold (1980a, b & 1990), King and Roberts (1982), Shea (1985) and Morris and Alford (unpub). These surveys concentrated on the mainland, particularly Edel Land, Peron Peninsula, the adjacent country to the south and east, and the small islands in the Freycinet Estuary. The first account of herpetofauna of Dirk Hartog Island was made by Burbidge and George (1978) who listed 30 terrestrial species, although no data were included on abundance or habitat preferences.

During visits by me in May 1982 and January 1984, a further 3 species were recorded as new to the island and habitat information for many species was noted (Maryan et al 1984). A subsequent visit in April 1992 added *Cryptoblepharus plagiocephalus*. This annotated list is based on the above visits as well as information gained during an investigation of all relevant literature and reptile records in the Western Australian Museum.

The vegetation on the island has been mapped and described by Beard (1976). A detailed description of the Dirk Hartog vegetation by Burbidge and George (1978) listed 5 different communities: Tall open-heath, Low closed/open heath, Low open heath, Hummock grassland and Low open shrubland. A brief interpretation of the island's biogeographical relationship is given by Storr and Harold (1990) stating that Dirk Hartog Island forms a part of the western zone which has mainly white sands over limestone, a mean annual rainfall of about 30 cm (mostly falling in winter), having no standing surface water and a vegetation consisting of coarse dune grass *Spinifex longifolius*, *Triodia* spp. and several species of tall and low shrubs.

Collecting methods involved raking through leaf litter and other surface debris, turning over rocks, logs and rubbish, headtorching and the use of a single drift fence with 10 pitfall traps (trapnights: 50) installed on a coastal dune during the April 1992 visit.

ANNOTATED LIST

Myobatrachidae

Arenophryne rotunda, Tyler 1976.

The WA Museum has two records for the island.

Gekkonidae

Crenadactylus ocellatus horni (Lucas & Frost 1895)

Common. Beneath corrugated iron, especially at rubbish tip near homestead and at night on tracks in tall open-heath over *Plectrachne* sp. Probably common in all areas of *Plectrachne* and *Triodia* on the island.

Diplodactylus ornatus, Gray 1845.
Common. Beneath corrugated iron, especially at rubbish tip near homestead and at night on tracks in tall open-heath over *Plectrachne* sp. Also beneath rubbish strewn around bores.

Diplodactylus spinigerus spinigerus, Gray 1842.
Very common at night on a variety of tall shrubs, especially *Acacia* spp. in tall open-heath and on sand dunes. The Shark Bay population has distinctive white eyes (Wilson and Knowles, 1988).

Gehyra variegata (Dumeril & Bibron 1836)
Very common under corrugated iron and other rubbish during the day and on tall shrubs at night.

Heteronotia binoei (Gray 1845)
This ubiquitous gecko is very common beneath corrugated iron at rubbish tip, around bores and at homestead. Also found beneath exfoliated limestone above rocky cliffs.

Nephrurus levis occidentalis, Storr 1963.
Common beneath rubbish, exfoliated limestone on soil and active at night on tracks in tall open-heath.

Underwoodisaurus milii (Bory 1825)
Very common where broken limestone cliffs provide shelter, beneath slabs and in crevices. Also occupies the many small crevices in the limestone walls of homestead. Commonly pit-trapped on the coastal dune in April 1992.

Pygopodidae

Delma butleri,Storr 1987.
The WA Museum has five records from the island. Probably inhabits the areas dominated by *Plectrachne* and *Triodia*.

Lialis burtonis, Gray 1835.
Common in living and dead *Plectrachne* and *Triodia* clumps. Also seen active in tall open-heath and among Spinifex on sandy beaches and dunes.

Pygopus lepidopodus (Lacepede 1804)
Burbidge and George (1978) recorded it on the island.

Agamidae

Ctenophorus maculatus maculatus (Gray 1831)
Very common in all low vegetation types, but favouring tall open-heath over hummock grass, dunes and coastal limestone.

Ctenophorus reticulatus (Gray 1845)
Very common beneath corrugated iron at rubbish tip, around bores and homestead. Also shelters beneath limestone slabs above cliffs.

Pogona minor minor (Sternfeld 1919)
Uncommon. Seen basking on shrubs in tall open-heath and active among Spinifex on sandy beaches.

Tympanocryptis butleri (Storr 1977)
Only found on dunes. Individuals were excavated at night in open areas and seen during the day among low shrubbery and hummock grass. Maryan (1992) provides a description of how this lizard was located at night.

Scincidae

Cryptoblepharus carnabyi, Storr 1976.
Very common on coastal limestone, piles of driftwood and dead logs on beaches.

Cryptoblepharus plagiocephalus (Cocteau 1836)
A single adult collected in April 1992 on dead Acacia shrub in tall open-heath. This lizard also appears scarce on the adjacent mainland with only a single record from the far south of Edel Land (Storr and Harold 1990).

Ctenotus fallens, Storr 1974.
Very common beneath corrugated iron, rubbish, limestone slabs and excavated from under hummock grass in tall open and closed-heath as well as dunes.

Ctenotus lesueurii (Dumeril & Bibron 1839)
Scarce in comparison to the similar looking *C.fallens*. Two sub-adults seen active in tall open-heath over *Plectrachne* in April 1992.

Ctenotus youngsoni, Storr 1975.
Uncommon. Collected beneath corrugated iron at rubbish tip and near homestead, also excavated from beneath hummock grass clumps on dunes.

Cyclodomorphus branchialis (Gunther 1867)
Common beneath a variety of surface debris: Acacia leaf litter, dead logs/stumps and hummock grass clumps. Prefers the deep leaf

litter on sandy beaches vegetated mainly with coastal Spinifex.

Egernia stockesii badia, Storr 1978.

Scarce. Prefers the limestone cliffs sheltering in crevices, also found beneath corrugated iron at homestead.

Lerista elegans (Gray 1845)

Common. Collected beneath a variety of surface debris on dunes and in tall open and closed-heath: beneath dead logs/stumps, living and dead hummock grass clumps and low shrubs. Maryan *et al* (1984) incorrectly listed this species as new for the island. It was previously recorded by Burbidge and George (1978).

Lerista lineopunctulata (Dumeril & Bibron 1839)

Very common in littoral vegetation on sandy beaches and dunes near the coast, becoming less common inland. Found beneath Acacia leaf litter, rubbish and dead logs/stumps.

Lerista planiventralis planiventralis (Lucas & Frost 1902)

Common. Mainly found on dunes by following their conspicuous meandering tracks during the day and night. Also collected beneath corrugated iron and Acacia leaf litter in tall open-heath at rubbish tip.

Lerista praepedita (Boulenger 1877)

Very common beneath a variety of surface debris as for *L.elegans*.

Lerista varia, Storr 1986.

Common beneath Acacia leaf litter and dead logs/stumps in tall open-heath. Not found in coastal habitats favoured by *L.lineopunctulata*.

Menetia greyii, Gray 1845.

Scarce. Only four individuals have been sighted. Found beneath corrugated iron at rubbish tip, Acacia leaf litter and hummock grass clumps in tall open-heath.

Morethia lineoocellata (Dumeril & Bibron 1839)

Very common. Active in all types of low vegetation, particularly among hummock grass clumps in tall open-heath and on dunes. Found sheltering beneath corrugated iron, other rubbish and limestone slabs.

Tiliqua rugosa (Gray 1827)

Scarce. Only one adult collected in April 1992 beneath corrugated iron at rubbish tip near homestead.

Varanidae

Varanus gouldii (Gray 1838)

Uncommon. Observed on tracks during the day in tall open-heath.

Boidae

Antaresia stimsoni stimsoni (Smith 1985)

Collected at rubbish tip beneath a pile of corrugated iron and beneath limestone rock in low open shrubland. During April 1992 several sloughs were found on limestone cliffs. Commonly seen around homestead during warmer months (T. Wardle, pers. comm.).

Elapidae

Demansia calodera, Storr 1978.

Uncommon. Found beneath corrugated iron at homestead, dead logs/stumps and seen active among hummock grass clumps in tall open-heath.

Demansia psammophis reticulata (Gray 1842)

Common beneath a variety of surface debris: corrugated iron and other rubbish, exfoliated limestone above cliffs, dead shrubbery and hummock grass clumps. Seen active among low shrubs on dunes and in littoral vegetation on sandy beaches.

Pseudechis australis (Gray 1842)

Only two individuals observed: one beneath a pile of corrugated iron in littoral vegetation on sandy beach and the other active at night inside unused shed at homestead. Probably more common than the few sightings indicate.

Pseudonaja nuchalis, Gunther 1858.

Only three collected from beneath corrugated iron at rubbish tip.

Vermicella fasciolata fasciolata (Gunther 1872)

Common. Found beneath corrugated iron at rubbish tip, coastal Spinifex clump on sandy beach and seen active at night in tall open-heath over *Plectrachne*. The animals from this island are atypical possessing 18-19 midbody

scale rows compared to 17 from elsewhere.

Vermicella littoralis, Storr 1968.

Very common in sand beneath a variety of surface debris: corrugated iron at rubbish tip and homestead, dead logs/stumps and living/dead hummock grass clumps in tall, closed open-heath. Also found active at night on tracks and dunes.

DISCUSSION

The herpetofauna diversity in the Shark Bay area is possibly a result of location. It is situated at the meeting point of three major natural regions: 1) south-western with relatively mild summers and wet winters, 2) northern with hot, wet summers and warm, dry winters and 3) eremaean with hot, dry summers and cold, dry winters (Storr and Harold 1990). Using this as a guide and excluding the southern peninsula Edel Land, Dirk Hartog Island would represent the northern most point of the south-western natural zone. This is reflected by the number of southern species that reach their northern limit here, the geckos *Diplodactylus s. spinigerus* and *Underwoodisaurus milii*, the pygopodid lizard *Pygopus lepidopodus*, the agamid *Tympanocryptis butleri*, the skinks *Ctenotus lesueurii* and *C.youngsoni* and the snake *Demansia p. reticulata*. Generally the island's herpetofauna consists of species that have primarily coastal or near coastal distributions, and species that are widespread throughout Australia like the common geckos *G.variegata* and *H.binoei*. The Shark Bay area is notable for herpetofauna endemism and disjunct populations of species on Edel Land that reoccur much further south. Considering the size of this island and the high number of species on the adjacent mainland, it is possible that future field work will reveal the presence of additional taxa.

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HERPETOLOGICAL OBSERVATIONS IN STURT NATIONAL PARK, NORTHWESTERN NEW SOUTH WALES, WITH A COMMENT ON *CTENOTUS UBER* AND *C. ASTARTE*

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ABSTRACT

During two surveys lasting seven days in total, four species of frogs and 18 species of reptiles were observed in Sturt National Park. The most interesting results include the observation of the frogs *Notaden bennettii* and *Cyclorana platycephala*, which are only active after heavy rains, and of the rarely encountered snake *Demansia torquata*, the first record of *Litoria rubella*, *Neobatrachus cf. sudelli*, *Diplodactylus byrnei*, *Rhynchoedura ornata*, *Lerista muelleri* and *L. punctatovittata*, the syntopy of the two similar-sized *Lerista labialis* and *L. xanthura*, the early seasonal reproduction of *Morethia boulengeri* in 1991, the survival of *Diplodactylus byrnei*, *Morethia boulengeri*, and perhaps other species on recently flooded plains, and the observation of an unusually patterned *Ctenotus* population tentatively assigned to *C. uber*. The pattern of this population is compared with other *C. uber* populations and with *C. astarte*. It is argued that *C. astarte* as currently recognized is a composite species.

A list of all species currently known from Sturt National Park is presented. The herpetofauna of Sturt National Park is compared with published data on other conservation areas in the arid or semiarid zone of New South Wales. Except for wide-spread species, the herpetofauna of Sturt National Park complements those of Kinchega National Park, Mungo National Park, Yathong Nature Reserve, and Round Hill Nature Reserve.

INTRODUCTION

National parks and nature reserves play an important role in the conservation of biodiversity. Most of the arid zone of New South Wales is used as sheep (and cattle) rangeland but it also contains several larger national parks and nature reserves, the largest being Sturt National Park (McAllister, undated). A basic requirement for devising management strategies for protected areas and for optimizing the selection of additional areas for conservation (Margules et al., 1988) is a sufficient knowledge of the faunal composition of existing reserves and of the habitat and area requirements of the component species (Witting & Loeschcke, 1993).

In contrast to the Western Australian wheat belt, for which the results of herpetofaunal surveys of many remnants of native vegetation have been published (e.g. Kitchener et al. 1980), published data on the herpetofaunas of the arid zone of New South Wales remain limited. Cogger (1984) and Caughley (1985) surveyed Round Hill Nature Reserve. Henle (1987) reported on the herpetofauna of Yathong Nature Reserve and analysed lizard and subterranean snake communities of Kinchega National Park (Henle, 1989a, 1990a). Sadlier & Shea (1989) summarized herpetofaunal surveys in Mungo National Park. To my knowledge, the only publication on the herpetofauna of Sturt National Park is that of Longmore & Lee (1983) who examined the effects of fire on the herpetofauna of a mulga sand dune system.

SURVEY AREAS AND METHODS

Sturt National Park lies in the northwestern corner of New South Wales. The park has a size of 3,106 km^2. Three major landscapes can be found: 1) the gibber plains which are a stony very gently rolling landscape primarily situated in the east and almost treeless except along creeks and gullies, 2) mesetas

or rock outcrops with sparse vegetation but including shrubs and trees on protected faces of slopes, and 3) undulating red sand dunes with a sparse cover of mulga in the west as an extension of the Strezlecki Desert. All sampled areas lay below 200 m a.s.l. During the former use of the park for sheep grazing, bore holes were installed which contain water most of the time even during droughts. All creeks are ephemeral but can flood large areas after rare intensive rains. Rains are sporadic and rainfall averages 223 mm per year. Mean monthly maximum and minimum temperatures range from 17.6-35.9°C and 5.5-22.3°C, respectively (Cunningham et al., 1981).

Herpetological surveys were carried out during two visits. From 19–22 May 1987, I sampled areas in all three major landscapes. The second survey from 28–30 November 1991 was restricted to the gibber plains and mesetas. Except around Mt. Wood Station where spotlighting was performed on three nights, all searches for amphibians and reptiles were carried out during the day by searching for active individuals and by carefully inspecting potential hiding places.

Most sampling during the two field trips was concentrated around Mt. Wood station and the Gorge Look Out at Twelve Mile Creek. Mt. Wood station is located between a narrow floodplain of Wittabrenna Creek and flat gibber plains (Fig. 1). Due to the proximity of the creek, bushes and trees are relative abundant. The creek itself is bordered by red gum *(Eucalyptus camaldulensis)*. The Gorge Look Out is a stony and rocky northerly and easterly facing slope covered with small bushes (approximately 2.5% coverage), trees (approximately 2.5%, mainly *Angophora melanoxylon*), and various dwarf scrubs (primarily *chenopods*) and dry herbs (< 5%); on the ridge, bushes were denser covering up to 10% of the area (Fig. 2).

A few voucher specimens of a *Ctenotus* species difficult to identify have been deposited in the Australian Museum (AM) and the Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK). ANWC is used as acronym for the Australian National Wildlife Collection, CSIRO, Canberra.

RESULTS

Weather conditions during the first survey were typical for the time of the year. A week before the second survey, heavy rains fell after a prolonged period of drought (five years without rain at Mt. Wood station; local warden, pers. comm.), and most roads still were partly inaccessible. Nevertheless, all creeks already were dry again except for a small number of pools. However, ephemeral pools on flood plains still provided breeding habitats for frogs. Intensive choruses were heard from a large temporary pond (approximately 100 x 20 m broad, 70 cm deep) behind Mt. Wood station and from the nearby Mt. Wood tank which usually contains water throughout the year.

The following four species of amphibians and 18 species of reptiles were recorded:

ANURA:

Hylidae:

Cyclorana platycephala

At least ten males were calling from a temporary pond behind Mt. Wood station. Two individuals were floating on the water surface but dived upon approach.

Litoria rubella

In May 1987, I found approximately 100 recently metamorphosed froglets at Mt. Wood tank. Two subadult individuals were active at Mt. Wood quarters. Numerous males were calling from a temporary pond behind Mt. Wood station, from Mt. Wood tank, and the nearby Wittabrenna Creek in November 1991. Most males called within shallow hollows in the steep bank.

Leptodactylidae:

Neobatrachus cf. sudelli

In May 1987, a recently metamorphosed individual was found at Mt. Wood tank. In November 1991, numerous males called from a temporary pond behind Mt. Wood station and from Mt. Wood tank. Most calling males

floated in water.

The field guide by Barker et al. (1995) indicates only *N. centralis* for the region of Sturt National Park. Morphologically, only one adult individual was examined. It was very similar to the numerous *Neobatrachus* individuals observed by myself in Kinchega National Park. Also, the calls sounded identical to me. The specific identity of the Sturt and Kinchega National Park specimens is difficult to determine, as they show intermediate and typical features of both *N. sudelii* and *N. centralis*. As in general appearance the examined adult and the Kinchega specimens are more similar to *N. sudelii* from eastern New South Wales and the ACT and differ from *N. centralis* from South Australia, I prefer to call them *N. cf. sudelii* until larger series have been examined morphologically, bioaccoustically and genetically.

Notaden bennettii

In November 1991, a chorus of at least 25 individuals was heard at a temporary pond behind Mt. Wood station.

SAURIA:

Gekkonidae:

Diplodactylus byrnei

Numerous individuals were active on the ground on the flood plain at Mt. Wood station in November 1991. This area was flooded and completely but shallowly covered by water except for a few emergent bushes for periods varying from a few hours to approximately a day only a week before the observations (flood signs and pers. comm. by resident warden). There were no signs left of rapidly flowing water. Whether *D. byrnei* survived the flooding by climbing bushes or remaining within their normal retreats (spider and cricket burrows) is unclear. Some individuals already had taken up new (still existing ?) burrows up to 200 m away from the next bush available for climbing. If they survived by climbing bushes, there must have been a high agglomeration on the few bushes as the encounter rate was approximately 20 individuals. In comparison, *D. tessellatus* encountered at a rate of 10-15 specimens/hour (Henle, unpubl.) on a similarly bare flood plain area in Kinchega National Park had an estimated population density of approximately 100 individuals/ha (November) (Henle, 1990b). All observed females were gravid with two eggs.

Gehyra variegata

Gehyra variegata was common at the huts of Mt. Wood station and quarters. Along the nearby creek, I could not find any individual on red gum *(Eucalyptus largiflorens)* whereas I discovered it under the bark of this species at Wittabrenna Creek close to the crossing of the Gorge Loop road. In Kinchega National Park, it is occasionally found during the day under bark laying underneath red gums but only exceptionally observed on the trees themselves (Henle, unpubl.). Additionally, I found *G. variegata* in mulga on red sand dunes approximately 500 m NE of Frome Tank (four adults and one first-year juvenile within 30 min. of search). At Gunya Creek, approximately 500 m SE of Gum Hole Tank, and at the Gorge Look Out, I discovered two adult *G. variegata* underneath large stones and under exfoliating rocks, respectively. Considering my experience during daytime searches in Kinchega, *G. variegata* seems to be fairly common in Sturt National Park. Presumably, *G. variegata* can be found throughout Sturt National Park along creeks with sufficient trees and throughout the mulga of the Strezlecki Desert but probably has a low density in mulga as is the case in *Dodonaea* dominated dunes in Kinchega (Henle, 1990c).

One egg was found in a cone of a broken-off branch of a dead tree near Mt. Wood station in May 1987. The egg was still whitish and did not show the dirty-yellowish rough surface of old infertile eggs (which usually can be discriminated from viable eggs by this feature; unpubl. pers. experience with a population in Kinchega). How et al. (1986) observed an extended reproductive period for some

Diplodactylus species of more northern (hotter) arid regions, and *Gehyra* species of tropical semiarid Australia are also known to have an extended reproductive period (Bustard, 1964). Nevertheless and in spite of January May 1987 having been unusually hot, this single observation should not be taken as a proof of an extended reproductive period in *G. variegata* compared to populations living in cooler environments (Henle, 1990c).

Heteronotia binoei

Heteronotia binoei was the most frequently observed gecko species. It was the most abundant species at the Mt. Wood quarters in May 1987 (individuals underneath almost all larger ground cover). It also was frequently observed at night, hunting in the leaf litter of the nearby Wittabrenna Creek. At the Gorge Look Out, ten individuals were found under exfoliating rock within one hour of search. A similar density occurred under rocks in Gunya Creek approximately 500 m SE of Gum Hole Tank. One individual was found in the dry bed of Frome's Creek, approximately 2 km W of Banncania Waterhole.

In May, three size classes were observed: first-year juveniles, subadults (probably mainly in their second year - compare Henle, 1990b), and large adults. In all populations, males were present but outnumbered by females (significantly at Mt. Wood station: 2:10; $x^2 = 5.3$; < 0.05).

Rynchoedura ornata

One gravid female was found at Mt. Wood quarters in November 1991.

Agamidae:

Ctenophorus nuchalis

In May, I observed subadult individuals in mulga at the edge of the track along Frome's Creek in the area about 2 km W to 4 km SE of Banncannia Waterhole. Upon approach, they dashed into burrows. One of the burrows was approximately 25 cm deep.

Pogona vitticeps

One subadult individual was sun-basking in Frome's Creek 2 km W of Banncannia Waterhole.

Scincidae:

Cryptoblepharus carnabyi

One individual was found underneath bark in mulga 500 m NE of Frome Tank.

Ctenotus leonhardii

One individual was observed catching a moth in mulga at Frome's Creek 2 km W of Banncannia Waterhole.

Ctenotus regius

In November 1991, one individual was found underneath corrugated iron at Mt. Wood quarters and two were hunting around *Maireana* bushes at the base of Mt. Wood. The soil consisted of hard compressed sand.

Ctenotus cf. uber

This species was very common in May 1987 on the rock outcrops at the Gorge Look Out. Some were active while others hid underneath rocks (several fast asleep), and several specimens could be caught. In November 1991, fewer individuals could be observed, all active, often with a considerable flight distance, and only a single additional individual could be secured. They are tentatively identified as *C. cf. uber* (see discussion).

Lerista labialis

Within 30 min of search in mulga 500 m NE of Frome Tank, I discovered five adults and one first-year juvenile underneath branches. An additional individual was found underneath bark in Frome's Creek 2 km W of Banncannia Waterhole. All but one individual were partially covered by sand; the remaining one was laying on sand. All individuals tried to escape by burrowing.

Lerista muelleri

One adult specimen was observed underneath a large stone at the Gorge Look Out in November 1991.

Lerista punctatovittata

The complete slough of an adult was found within red gum leaf litter on the bank of Wittabrenna Creek behind Mt. Wood quarters.

Lerista xanthura

While trying to catch an escaping *L. labialis,*

one adult individual was dug out from loose sand underneath an approximately 50 x 5 cm piece of bark in mulga 500 m NE of Frome Tank.

Menetia greyii

One adult was observed in a lump of dry branches hunting insects in Frome's Creek, 2 km W of Banncannia Waterhole.

Morethia boulengeri

Morethia boulengeri was the most commonly encountered diurnal lizard. It was very common around Mt. Wood quarters and at nearby Wittabrenna Creek. The species was still observed in this area after the November 1991 flood. It may have survived by climbing trees, small bushes, or the huts at the quaters. One live adult was dug out of a dense mat of leaves, bark, and dry herbs and grasses accumulated on a mud bank surrounded by receding water in the Wittabrenna Creek crossing at Mt. Wood station. This observation suggests that *M. boulengeri* may drift down-stream with floods and survive passive dispersal.

M. boulengeri further was found at the Arcoola Creek and Wittabrenna Creek crossings of the Gorge Look Out Loop road within hummock grass and underneath a branch in the dry creek bed, respectively. I also observed it close to the top of Mt. Wood in almost bare rock outcrops where it was active in the midday heat. Along the track to the top of Mt. Wood, two further individuals and frequent fecal droppings probably belonging to this species were seen. The track passed along the rocky and bolder-strewn gully of Mt. Wood Creek; large bushes covered approximately 25% of the gully.

At the Gorge Look Out, *M. boulengeri* was the most frequently encountered species with 15-20 individuals per hour of search. In May, adults, half-grown individuals (approximately 35 mm snout-vent-length [SVL]), and one fairly recently hatched juvenile were found. In Kinchega National Park, most first year juveniles were also approaching adult size at the same time of the year (Henle, 1989b). Surprisingly, in November 1991, juveniles of approximately 20-22 mm SVL and one subadult of approximately 30 mm SVL were also observed. In Kinchega, the former size usually is surpassed approximately 1-3 weeks after hatching and the latter one after 1-2.5 months (Henle, 1989b and unpubl.). Thus, these individuals must have hatched from extremely early clutches (deposited in mid September and mid-to-late August, respectively), as usually approximately two months elapse between first observations of egg deposition to the appearance of the first hatchlings (Henle, 1989b). Alternatively but less likely, they hatched the previous season (March) and survived with no or very limited growth.

Males already had lost most of their breeding colouration but a few females were still ovigerous. In Kinchega National Park, breeding colouration also had faded in most males in November 1991, but juveniles were not seen until early January as in previous years (Henle, 1989b). The (partially) advanced reproduction (2-3 months earlier in Sturt National Park than in Kinchega where juveniles always appeared for the first time in January [Henle, 1989b, and unpubl.]) indicates that, geographically, the reproductive timing of *M. boulengeri* is more plastic than previously assumed (Henle, 1991).

Trachydosaurus rugosus

One adult individual was found at Mt. Wood station in November 1991.

SERPENTES:

Elapidae:

Demansia torquata

One individual was found underneath a rock at the Gorge Look Out.

DISCUSSION

Herpetofaunal Comparisons

Subterranean reptile communities are generally depauperate, and in other communities, syntopic fossorial species always clearly differ in size (see review in Henle, 1990a). Thus, the syntopic occurence of two similar-sized *Lerista* species is remarkable.

Due to excellent breeding conditions during the November 1991 field trip, rarely encountered frog species could be recorded, like *Cyclorana platycephala* and *Notaden bennettii*. Nevertheless, the frog species list is likely to be incomplete as is definitely the case with the reptile species list. During their 15-day survey, Longmore & Lee (1983) found 19 (+ 1 unidentified) species of reptiles in their mulga study sites whereas I observed 18 species. Of their species, ten were not observed in my surveys (see Table 1). In contrast, *Diplodactylus byrnei*, *Rhynchoedura ornata*, *Lerista muelleri*, *L. punctatovittata*, and the four frog species are recorded for the first time from Sturt National Park. The general distribution area of all these species but *Notaden bennetti* covers Sturt National Park (Cogger, 1992). The latter is a slight range extension to the west.

The distribution maps of Swan (1990) based largely on museum material show further records for 11 and 7 species of lizards and snakes, respectively, bringing the total to 37 and 9 lizard and snake species, respectively (Table 1). This compares with 23, 22, 31, and 27 lizard and 9, 1, 6, and 1 snake species, respectively, from Kinchega National Park (Henle, 1989a, 1990a, and unpubl.), Yathong Nature Reserve (Henle, 1987), Round Hill Nature Reserve (Cogger, 1984; Caughley, 1985), and Mungo National Park (Sadlier & Shea, 1989), respectively. (The snake lists for Yathong Nature reserve and for Mungo National Park are certainly incomplete, e.g., in the vicinity of Mungo National Park, seven additional species have been found (Sadlier & Shea, 1989.). In spite of limited surveys, Sturt National Park exhibits the richest herpetofauna, which most likely is due to its large size and diverse ecosystems. Interestingly, Kinchega National Park has a rich snake fauna but a comparably poor lizard fauna. The reason for this is unclear.

Many widespread generalists like *Gehyra variegata*, *Diplodactylus damaeus*, *Rhynchoedura ornata*, *Heteronotia binoei*, *Cryptoblepharus carnabyi*, *Menetia greyii*, *Morethia boulengeri*, *Pogona vitticeps*, *Varanus flavirufus*, *Egernia inornata*, *Lerista punctatovittata*, *Menetia greyii*, and *Trachydosaurus rugosus* are shared by Sturt, Kinchega, and Mungo National Parks as well as Round Hill and Yathong Nature Reserves. In contrast, several species with a predominantly Central Australian or Western to Central Australian distribution (*Diplodactylus byrnei*, *Ctenophorus nuchalis*, *Ctenotus leonhardii*, *Lerista labialis*, *L. xanthura*, and *Demansia torquata*) are known only from Sturt National Park except for *D. byrnei* and *L. xanthura* which live in Round Hill Nature Reserve (Cogger, 1984) and Kinchega National Park (Henle, 1990a), respectively. With the exception of the widespread generalist species, the known herpetofauna of Sturt National Park differs strikingly from that of Kinchega National Park, reflecting differences in major habitat types (gibber plains, extensive mulga, small floodplains with very narrow or broken gallery forests, and large rocky outcrops in Sturt National Park; mainly *Maireana*-steppe, some pockets of *Callitris* pine, and extensive flood plains with gallery forests in Kinchega National Park).

Whereas rock outcrops are absent from Kinchega National Park, they form parts of Yathong Nature Reserve. Thus, it would be expected that Yathong would share rock outcrop species with Sturt National Park. However, this is only the case for *Cryptoblepharus carnabyi* and *Lerista muelleri*. Neither *Gehyra variegata*, *Heteronotia binoei*, *Morethia boulengeri* nor *Ctenotus uber*, all common on rock outcrops of Sturt National Park, have been recorded from rock outcrops in Yathong, though *G. variegata* and

M. boulengeri were found in mallee in Yathong. Furthermore, *Egernia striolata*, the most frequently observed rock outcrop species in Yathong, so far has not been recorded from Sturt National Park.

Interestingly, the frog fauna of Sturt National Park also differs noticeably from that of the other conservation areas. It shares only *Neobatrachus cf. sudelli* with Kinchega National Park (Henle, unpubl.) and *Litoria rubella* with Yathong Nature Reserve (Henle, 1987). The latter almost certainly is absent from Kinchega, whereas *Litoria caerulea* is common at Kinchega but has not reported from Sturt National Park; *L. caerulea* definitely is absent in the Mt. Wood station area. (Both species are readily observed under humid or rainy conditions.) Although conclusions must remain tentative due to limited survey efforts under suitable wet conditions, it appears that like for reptiles, Sturt National Park also provides habitat for a different set of amphibians than the other reserves.

Regarding optimal reserve selection under the criteria of species representedness (Margules et al., 1988), Sturt and Kinchega National Parks plus Yathong and Round Hill Nature Reserves complement each other well. As at least the former three reserves are fairly large, it appears likely that they can provide sufficient conditions for viable populations of their herpetofaunas perhaps save partially for the monitors and largest snakes. Under this situation, the critique of Witting & Loeschcke (1993) of current optimization procedures for reserve selection seems not to hold. However, no quantitative data on area requirements are available for any relevant species. Considering Caughley's (1985) observation of successional appearance and disappearance of various reptile species driven by fire, the area requirements may be larger than expected for small organisms, and consequently, area requirements may be an important criterium for species restricted to spinifex mallee in Round Hill and Yathong Nature Reserves. Although some attempts have been made to understand the complexity of fire ecology in mallee and its implication for conservation (e.g. Gill & Nicholls, 1989; Friend, 1993), so far, no attempts have been made to analyse how large mallee areas must be that natural or controlled fire can create the habitat mosaics necessary for the survival of these species. Interestingly, *Egernia inornata* formerly common in some parts of Kinchega National Park has disappeared for unknown reasons, *Tympanocryptis lineata* has become very rare, and *Diplodactylus tessellatus* fluctuated considerably in its commonness (Henle, 1989a, and unpubl.). Clearly, our knowledge of species distributions and the dynamics of arid and semiarid zone herpetofaunal communities are still too limited to decide upon the effectivness of the existing conservation sytem.

Taxonomic Problems with *Ctenotus uber* and *C. astarte*

The voucher specimens collected at the Gorge Look Out, ZFMK 49455 and AM R 138399 (Fig. 3), are very similar in pattern and colouration. In AM R 138399, the dark vertebral stripe is strongly reduced and indicated only on the anterior half of the body by faint light lines bordering it on both sides. It is more pronounced in ZFMK 49455 but also dissolves well in front of the hindlegs. The dark laterodorsal stripe is hardly discernible and ends above the forelegs. In both specimens, the white dorsolateral stripe is present only on the head and nape; posteriorly, it dissolves into small white spots which appear to be more an extension of the lateral white spots than of the dorsolateral line. The upper flanks are dark with numerous white flecks arranged in rows of usually three, each fleck only a single scale broad.

Both specimens superficially resemble *C. uber*, *C. schevilli*, and *C. astarte*. However, their pattern does not match any of these taxa sufficiently for a definite identification. A certain identification further is hampered by the variability of *C. uber*, which most likely comprises several species, some of which still lack

names (Shea, pers. comm.). Furthermore, *C. astarte* as currently recognized also is very variable, and even the type series may content two distinct taxa (see below). Because of the difficulty of identification, the two individuals were compared to specimens of *C. uber* deposited in the Australian Museum, Sydney (AM R 7139, 9538, 32604, 45525, 60055-6, 69731, 86081, 114385, 114483, paratype: 90488) and the Australian National Wildlife Collection, Canberra, (ANWC R0214, 1400-3, 1885, 2550, 2844, 3134-5, 4639-46, 5139), with specimens of *C. astarte* (AM R 113212-3; paratypes: ANWC R0742, R3133), and *C. schevilli* (AM R 62331, 62453). The examined specimens of *C. uber* included four specimens from Sturt National Park (AM R 32604: 30 miles N of Tibooburra; AM R 69731: Olive Downs; ANWC R3134-5: Mt. King).

Although usually fairly constant within populations, the pattern of the examined *C. uber* individuals is very variable among populations (Fig. 4). Nevertheless, most examined specimens of *C. uber* show a well defined dark middorsal stripe bordered by light lines and extending to or well beyond the base of the tail, a broad dark laterodorsal band enclosing a series of light spots, and a well-defined white dorsolateral stripe often extending beyond the base of the tail. This pattern is exemplified by the examined paratype of *C. u. uber*, by most examined *C. uber* individuals (Fig. 4), as well as by photographs of *C. u. orientalis* in Cogger (1992) and of *C. u. uber* in Storr et al. (1981). It clearly contrasts with the reduced dorsal pattern of the Gorge Look Out specimens (Fig. 3). The dark laterodorsal band is very broad in some individuals but narrow in others and may enclose light spots only anteriorly. It may dissolve on the posterior third of the back in some individuals, or rarely may be completely absent. The light spots often form a streak on the head. In most specimens, the upper flanks are brownish-black enclosing numerous white spots which are usually aligned in rows of 2-3 spots; each spot is usually 2-3, rarely only 1, scales broad. Thus, the colouration of the flanks of most examined specimens also deviates from the Gorge Look Out specimens by being more distinct and containing larger spots.

Apart from the Gorge Look Out individuals, a partial reduction of the dorsal pattern was observed only in few examined specimens of *C. uber:* slightly in ANWC 1400-3 (Fig. 4: lower row right) from the Nullarbor, 50 miles ENE of Rawlina, more strongly in AM R 69731 from Olive Downs, Sturt National Park, and in ANWC R3134 from Mt. King, Sturt National Park. In the Nullabor series, the small light flank flecks are only one scale broad as is the case in the Gorge Look Out specimens. However, their dark middorsal stripe is well pronounced beyond the base of the tail, and the light dorsolateral stripe is very distinct. Thus, their pattern is considerably more pronounced than in the Gorge Look Out individuals and does not bridge the gap to them (compare Figs. 3 and 4).

The individuals geographically closest to the Gorge Look Out specimens (approximately 20-40 km), ANWC R3135 from Mt. King (Fig. 4) and AM R 32604 from Tibooburra, show the pattern typical of most examined *C. uber* with all dorsal stripes clearly distinct and extending well beyond the hind legs. Additionally, the flanks are much darker and contrast much stronger with the dorsum than is the case in the Gorge Look Out individuals. Furthermore, the white dorsolateral stripe is well developed and extends to the base of the tail. Finally, the white lateral spots are 2-3 scales wide. Thus, the pattern of these individuals is similar to that found throughout the range of *C. uber* and distinct from the Gorge Look Out individuals. A second specimen from Mt. King (ANWC R3134) is more similar to the Gorge Look Out individuals than ANWC R3135. Though present and well defined anteriorly, its dark laterodorsal stripe dissolves at midbody into a uniformly coloured lateral dorsum. Nevertheless, as in typical *C. uber*, it has a distinct dark vertebral and white dorsolateral stripe both extending well beyond the base of

the tail. Thus its pattern is more similar to that of most examined individuals though it approaches the Gorge Look Out specimens.

AM R 69731 from Olive Downs has a slightly more reduced colour pattern partly reminiscent of the Gorge Look Out specimens (Fig. 4). As in the latter, the white dorsolateral stripe is broken into small spots and the dark laterodorsal stripe is distinct only to just behind the forelegs and completely dissolves at midbody. Throughout its length, it is partially interrupted. However, the vertebral stripe is much more pronounced and extends well beyond the base of the tail as in all other examined *C. uber*. The light lateral spots are only one scale broad as in the Gorge Look Out specimens and do not form well aligned transverse rows except for within the greyish lower lateral part. In contrast, the light spots are usually 2-3 scales broad and aligned in transverse rows in most of the other examined specimens.

As the Olive Down individual partly bridges the gap to the Gorge Look Out specimens, one could comfortably allocate these specimens to the same taxonomic form were it not for two facts. Firstly, *C. uber* shows relatively low intrapopulational variability in pattern and generally exhibits a well pronounced dorsal pattern, which can be found throughout the whole range of the species as currently recognized. Only very few individuals show a partial reduction of the dorsal pattern. This reduction is far more extreme in the Gorge Look Out population than in any other examined individual. Still, the reduced pattern could be explained by assuming the Gorge Look Out population to be fairly localized and isolated from other populations, allowing genetic drift to have caused the deviating pattern.

Secondly, the variation of specimens currently assigned to *C. astarte* causes additional complications. Czechura (1986) described *C. astarte* based on nine individuals originating from six localities in Queensland. He compared it to *C. schevilli* and another species described by him, *C. serotinus*, but not to *C. uber*. Some individuals currently assigned to *C. astarte* show a pattern which deviates only slightly more from the Gorge Look Out individuals or *C. uber* than the pattern of the latter from that of most *C. uber*. The individual figured in Wilson & Knowles (1988) and, to a lesser extend, the paratype ANWC R3133 are such examples. The former closely resembles the Gorge Look Out skinks in its reduced dorsal pattern and in the size and alignment of the light lateral spots. However, its flanks are much lighter (similar to the dorsum). No difference in the colouration between upper lateral zone and dorsum, and lack of a light dorsolateral stripe are also shown by a specimen from a paratype locality figured in Cogger (1992) which is much darker and with a less distinct pattern than the specimen figured in Wilson & Knowles (1988), the two examined paratypes, or the Gorge Look Out individuals. The skink figured in Wilson & Knowles (1988) resembles far more the Gorge Look Out specimens than it does the *C. astarte* individual figured in Cogger (1992). Both figured specimens are probably specifically distinct from each other and almost certainly do not belong to the same species as the paratypes of *C. astarte* deposited in the ANWC.

Paratype ANWC R3133 (Fig. 4) from the type locality (Cuddapan Station airstrip) has a distinct 1-scale-broad dark vertebral stripe bordered by partly obscure white stripes and a light dorsolateral stripe, though the latter is less distinct than in all examined *C. uber* except the Olive Downs and the Gorge Look Out individuals. All stripes extend well beyond the base of the tail. However, instead of a dark laterodorsal band, the ground colour is broken by regular light lines joining the dorsolateral light stripe and the light stripes bordering the vertebral stripe. The flanks bear 1-scale-broad white spots aligned in posteriorly directed bands (4-5 spots per row) slightly resembling the Gorge Look Out individuals. The flanks are darker than the back but less contrasting than in the Gorge Look Out specimens and all examined *C. uber*. In this character, it is intermediate between *C. uber* and

the *C. astarte* figured in Wilson & Knowles (1988). Thus, at least in one paratype of *C. astarte*, the upper flanks contrast with the dorsum [contrary to the key in Cogger, (1992)].

The paratype ANWC R3133 has 36 mid-body scale rows (like the second examined paratype [ANWC 0742] from Paton Downs, S of homestead at gate of dingo fence) whereas none of the *C. uber* examined exceeded 31; Cogger (1992) gives a maximum of 34 for *C. uber* [probably based on the range given by Storr (1970) when describing *C. u. orientalis*]. Also, its mental is indented posteriorly and not straight as in all examined *C. uber*, and its interparietal is slightly less narrow than in the examined *C. uber*. In these two features, it differs also from the second examined paratype which is like *C. uber* in this regard. No differences were found in the position of prefrontals and nasals [very variable within single populations of *C. uber* and certainly of no taxonomic value in spite of its use by Storr (1980) to diagnose the subspecies *C. u. johnstonei*], number of supralabials, supraciliars, ear spines, preoculars, postmentals, and 4th toe lamellae between the paratype and the Gorge Look Out individuals or typical *C. uber* (this applies also to the other examined *C. astarte* paratype). However, the toe lamellae are only slightly keeled in the *C. astarte* paratypes whereas they are distinctly keeled to mucronate in typical *C. uber*. In conclusion, although the *C. astarte* paratype ANWC R3133 is indeed specifically distinct from *C. uber*, it is more similar to *C. uber* in some features of its pattern than the Gorge Look Out individuals. Also, some morphological differences to *C. uber* and the Gorge Look Out individuals are not shared with the second paratype. At least in pattern, it is closer to several specimens of *C. uber* than to the *C. astarte* individual figured in Cogger (1992).

In *C. astarte* AM 113213, the dark vertebral stripe, the dark laterodorsal stripe, and the white dorsolateral stripe are broken into separate but transversally oriented spots, thus differing from most examined *C. uber* and the Gorge Look Out individuals. The dorsal ground colour is much darker than the flanks in contrast to the Gorge Look Out individuals, all examined *C. uber*, and the examined paratypes of *C. astarte*. It is also much larger and appears bulkier than the Gorge Look Out specimens and *C. uber*. AM 113212 is a juvenile similar to AM 113213 but with more pronounced transverse dark dorsal spots. Most deviating in pattern is paratype ANWC R0742 (Fig. 4). It has a diffuse indistinct dorsal pattern consisting of reticulations and regularly broken longitudinal stripes clearly different from all other specimens of *C. astarte* (though this pattern may be interpreted as a strong reduction of the pattern of the other paratype). A light dorsolateral stripe is at most faintly indicated. It is clearly distinct from all *C. uber* or the Gorge Look Out individuals in pattern and by having more dorsal scale rows and less keeled toe lamellae (as in the other examined *C. astarte*). It differs from the latter but not from *C. uber* by a posteriorly straight mental and a narrow interparietal.

From the examination of the material, it is very likely that more than one species is involved in *C. astarte* as currently recognized, and some are more similar in pattern to the Gorge Look Out individuals than to other *C. astarte*. Without a detailed examination of all material of *C. astarte* and related species as well as of larger series of *C. uber* from many different localities, it is impossible to resolve their taxonomic status. The distribution of *C. uber* just covers Sturt National Park whereas *C. astarte* and allied species are distributed slightly further north. Therefore, it seems best to regard the Gorge Look Out individuals tentatively as *C. uber* until the above taxonomic problems have been sorted out.

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Table 1: Checklist of amphibians and reptiles of Sturt National Park and references.

Species	Longmore & Lee (1981)	Swan (1990)*	this paper
Anura:			
Cyclorana platycephala			X
Litoria rubella			X
Neobatrachus cf. sudelli			X
Notaden bennettii			X
Sauria:			
Diplodactylus byrnei			X
D. ciliaris	X	X	
D. conspicillatus		X	
D. damaeus	X	X	
D. stenodactylus		X	
D. tessellatus		X	
Gehyra variegata	X	X	X
Heteronotia binoei		X	X
Rhynchoedura ornata			X
Delma tincta		X	
Pygopus nigriceps	X	X	
Varanus flavirufus	X	X	
Ctenophorus fordi		X	
C. nuchalis	X	X	X
Pogona vitticeps	X	X	X
Tympanocryptis intima		X	
T. lineata	X	X	
Cryptoblepharus carnabyi	X	X	X
Ctenotus brooksi	X	X	
C. leonhardii		X	X
C. regius	X	X	X
C. schomburgkii	X	X	
C. strauchii		X	
C. uber		X	X
Egernia inornata	X	X	
E. stokesii		X	
Eremiascincus fasciolatus	X		
E. richardsonii		X	
Lerista labialis	X	X	X
L. muelleri			X
L. punctatovittata			X
L. xanthura	X	X	X
Menetia greyii	X	X	X
Morethia boulengeri		X	X
Probablepharus kinghorni		X	
Tiliqua multifasciata		X	
Trachydosaurus rugosus	X		X

Serpentes:			
Liasis stimsoni		X	
Demansia torquata		X	X
Furina diadema		X	
Hemiaspis damelii		X	
Pseudechis australis		X	
Pseudonaja modesta		X	
P. nuchalis		X	
P. textilis		X	
Suta suta	X	X	

* Some of these species may actually have been recorded only in the vicinity of the park. Due to the size of the distribution maps, a definite inclusion within the boundary of the Sturt National Park is not always possible.

List of Figures

Figure 1: Plains at Mt. Wood station. Habitat of *Notaden bennetti, Cyclorana platycephala, Neobatrachus cf. sudellii, Litoria rubella, Diplodactylus byrnei, Gehyra variegata, Heteronotia binoei, Rhynchoedura ornata,* and *Morethia boulengeri.*

Figure 2: The Gorge Look Out, a sparsely vegetated stony slope. The unusually patterned *Ctenotus cf. uber* were observed along the slopes in the foreground.

Figure 3: *Ctenotus cf. uber* (AM R 138399) in life. Note the reduced pattern particularly on the posterior half of the dorsum. Compare with Figure 4.

Figure 4: Variability of pattern in *Ctenotus uber* and *Ctenotus astarte.* Top row (from left to right): *C. astarte* paratype: Paton Downs (Qld), S of Homestead, at gate on dingo fence; *C. astarte* paratype: Cuddapan Station airstrip (Qld); 2 specimens of *C. uber*, Mt. King, Sturt National Park; bottom row (from left to right): *C. uber*, Molonglo River (ACT); Eyre Peninsula (SA); approx. 50 m NE of Rawlina Street Station, Nullarbor. Compare with Figure 3.

INTERSPECIFIC IMMUNITY TO VENOM IN SNAKES

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The venoms of Tiger Snakes *Notechis* and Copperheads *Austrelaps* are neutralised in humans by the same monovalent anti-venom (Trinca, 1979). This indicates a similarity between venoms of both these genera.

During a six week period in early 1992, Darren Dawber of Plenty Lane, Greensborough, Victoria, held an 80 cm, male Tiger Snake *(Notechis scutatus)* from the Junction of the Acheron and Goulburn Rivers, Victoria (37° 14'S, 145° 42'E), in an indoor cage with a 98 cm Highlands Copperhead *Austrelaps ramsayi* from the Acheron River, Narbethong district, Victoria (37° 31'S, 145° 41'E).

Both snakes were fed on mice, which they took readily. On six separate occasions the *A.ramsayi* was seen biting the head of the *N.scutatus* during the feeding sessions. The bites appeared substantial, with the *A.ramsayi* chewing on the head of the other snake. This would have almost certainly resulted in envenomation on every occasion. The *N.scutatus* never displayed any ill effects from having been bitten by the *A.superbus.* At no time was the *N.scutatus* observed biting the *A.superbus.*

On 5th October 1995, Fred Rossignoli observed a captive 180 cm King Brown snake *Pseudechis australis* from near Whyalla, South Australia bite a 130 cm Eastern Brown Snake *Pseudonaja textilis* from 3 km north of Toolondo Reserve, Victoria (36° 59'S, 141° 56'E). The bite was on the dorsal mid-back region, slightly to one side of the spine. Within 2 hours the bite region had swollen to an enormous extent, being described by Rossignoli as being 'like a balloon'. This swelling appeared to peak about 6 hours after the bite and remained puffy in appearance for some hours after. 24 hours after the bite, virtually all the swelling had subsided, except for some minor swelling at the bite site (both fangs had penetrated). In another incident the same *P.australis* bit another 200 cm *P.australis* from near Glen Helen Homestead, Central Australia (23° 47'S, 133° 01'). On that occasion, the biting snake appeared to hang on to the other snake and 'pump' the venom glands. The bitten snake showed no ill effects from the bite. All the snakes held by Rossignoli were long term captives used as part of an educational display in an open pit.

In 1984 a long-term captive 1000 cm Speckled Brown Snake *Pseudonaja guttata* from an unknown locality accidentally bit itself, when striking at a live mouse in the same cage. The bite was in the middle of the snake's back, slightly to one side of the spine. The bite site swelled and some days later the flesh in the region appeared to be necrotic and oozing pus. The snake, held by Roy Pails of Ballarat, Victoria, died shortly after. The snake had previously been in perfect health. Since that time, Pails has noted captive Death Adders *Acanthophis antarcticus* and King Brown Snakes *Pseudechis australis* biting one another without apparent ill effect. This has been observed 'dozens' of times.

In the period 1981-84, the author held Death Adders *Acanthophis antarcticus* and Desert Death Adders *Acanthophis pyrrhus* in substantial numbers. On many occasions both species were held together in the same cages. Despite the certainty of the snakes bit-

ing one another accidentally, no deaths as a result of envenomation occurred.

Kellaway (1931) concluded that Australian snakes are not only immune to their own venom, but also similar venoms from other snake species. The information here corroborates Kellaway's finding. Most herpetologists appear to think that Australian snakes are immune to their own venoms, including Fleay (1937, 1951), Hoser (1985), Kinghorn (1964) and Worrell (1970).

Hoser (1985) not only documented cases of immunity of snakes to their own species venoms, but also two cases of alleged non-immunity by the same or similar snake species which could warrant further investigation. Van Woerkom (1985) and Stettler (1985) documented a case of two healthy three and a half year old *Acanthophis* sp. dying after being bitten by a third specimen which had come from the same litter, all three having been born in captivity.

Douglas, Nichol and Peck (1933) concluded, after experimentation, that some highly venomous viperids from North America had no exceptional immunity to their own venoms within the context of injection by one snake into another similar snake.

Clearly immunity of snakes to snake venoms warrants further investigation.

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POGONA BARBATA ON KANGAROO ISLAND, S.A.

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The Eastern Bearded Dragon (*Pogona barbata*) is a large, common and well known species of eastern Australia. In South Australia its range includes Southern Fleurieu Peninsula, Yorke Peninsula and Eyre Peninsula. (Houston 1978, Cogger 1992, Ehmann 1992). While none of these authors includes adjacent Kangaroo Island in its known range, a small population does exist on the island. This population appears to be centred on the township of Kingscote (35°39' S, 137°38' E). The author is aware of 19 records of *P.barbata* from Kangaroo Island (Table 1). The earliest of these records was in 1977. Nine of the nineteen records are from Kingscote and adjacent Brownlow. (Two of these nine records are unspecified multiple sightings reported to National Parks personnel by residents). All other records are from within a 20 kilometre radius of Kingscote (Figure 1). This distribution represents less than 10% of Kangaroo Island's 4500 square kilometres.

Early fauna surveys of Kangaroo Island make no mention of *P.barbata*. (Waite 1927, Condon 1941, Houston and Tyler 1979). It seems highly unlikely that *P.barbata* would have been overlooked for so long, considering the species is very prominent and easily observed. Its distribution on Kangaroo Island, centred on the main settlement Kingscote, again suggests that it would have been observed much earlier had it been present. It seems highly probable therefore that *P.barbata* is a recent addition to Kangaroo Island's herpetofauna, the restricted distribution on the island, and the lack of early records, giving further support to this view.

If *P.barbata* is in fact a recent occurrence on Kangaroo Island three modes of introduction seem possible; a) escape from captivity, b) rafting on debris from the mainland, perhaps as a result of flash flooding, and c) accidentally transported in freight or farm equipment from the mainland. Escape from captivity seems most likely considering the high proportion of records from the township of Kingscote, particularly during the period 1977 to 1989.

ACKNOWLEDGEMENTS

I would like to thank David Armstrong and Terry Dennis (NPWS), Mark Hutchinson (South Australian Museum), Tony Nolan and Craig Wickham for providing their records of *P.barbata*, and Terry Dennis for making helpful comments on this paper.

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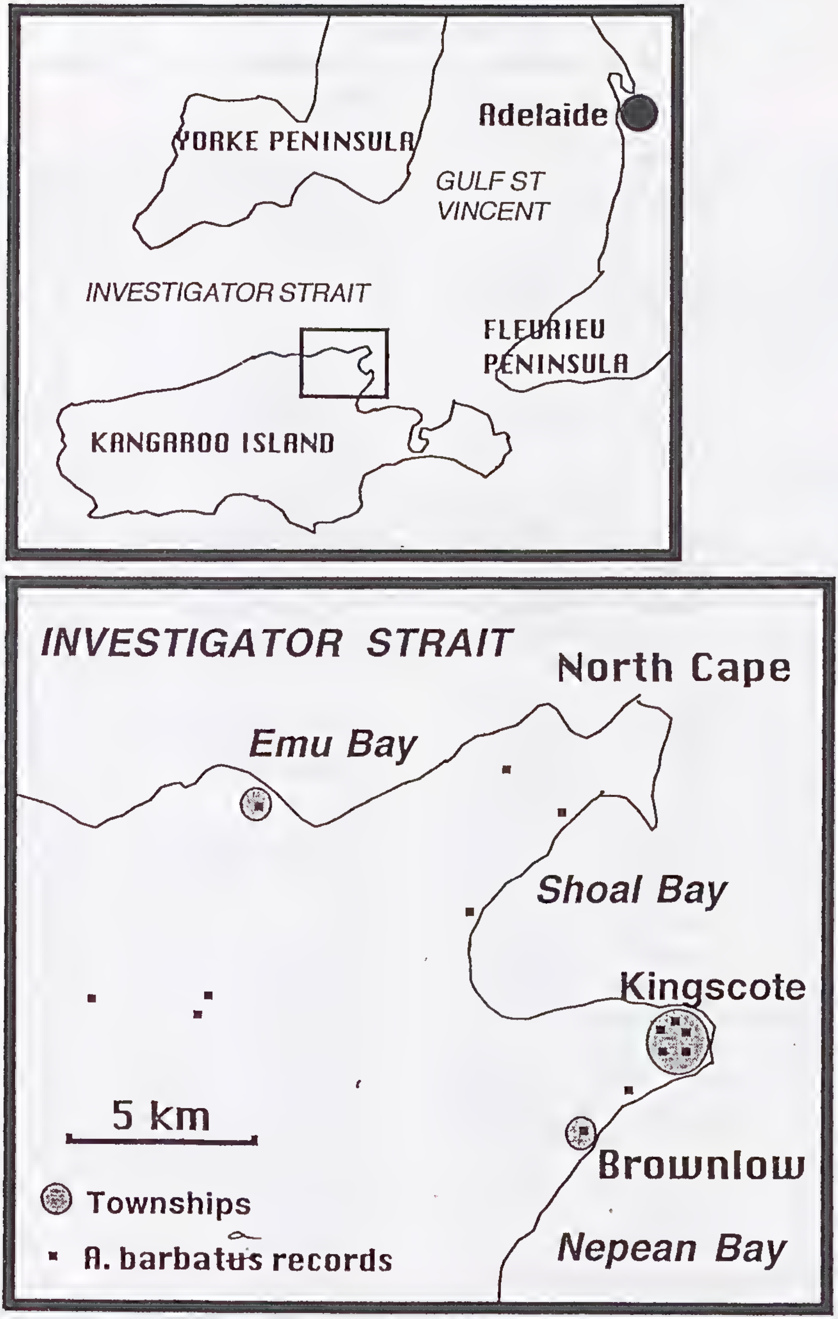
Figure 1


Adelaide
YORKE PENINSULA
GULF ST
VINCENT
INVESTIGATOR STRAIT
FLEURIEU
PENINSULA
KANGAROO ISLAND
INVESTIGATOR STRAIT
North Cape
Emu Bay
Shoal Bay
Kingscote
5 km
Brownlow
Townships
Nepean Bay
A. barbatus records

AN INNOVATIVE STRATEGY FOR THE DETECTION OF EGG-DEPOSITION IN CAPTIVE VARANID REPTILES

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Varanids are oviparous reptiles which exhibit a number of egg-deposition strategies (King & Green 1993a). Some species, such as *Varanus varius*, *V.giganteus* and *V.gouldii*, lay their eggs in termite mounds (King & Green 1979), others deep in the soil, including in communal warrens (King & Green, 1993b). Clutch size is positively correlated with body length (King 1991) and normally only a single clutch is produced in the wild. Double clutching is known in captive varanids (Horn & Visser 1989; S. Irwin unpubl. data). The timing of breeding is also variable with marked differences between sympatric species (Shine 1986; James et al 1992).

The Qld Reptile and Fauna Park at Beerwah, Queensland has maintained a successful varanid breeding program since the early 1970s. The detection of egg-deposition and removal of eggs soon after, has been a necessary part of this program to ensure that eggs are incubated in a controlled environment. This heightens the chances of hatching success, removing potentially deleterious factors such as predation by other varanids, temperature fluctuations, insect damage and flooding. The recognition of gravid females in captivity by the characteristic distension of the abdominal cavity is sometimes difficult if they are in good condition, as the abdomen may also appear enlarged. The female goanna's behaviour also mitigates against observation, as she becomes more secretive and nervous during the breeding season.

Auffenberg (1988) noted that some gravid female varanids become so distended that they are unable to feed for several weeks prior to egg-deposition. We have independently developed a strategy of egg-deposition using a related recognition of feeding behaviour.

When a female varanid is suspected of being gravid, either during or outside her recorded reproductive season at the Park, food is restricted so that she is left hungry enough to eat a similar-sized portion the following day. The size of each day's food item offered is small (usually a single House Mouse *Mus musculus* in the case of adult female *Varanus giganteus*, *V.gouldii* and *V. mertensi*).

Close attention is paid to any female that is potentially gravid. As each animal gets closer to the time of oviposition, her interest in food decreases with a corresponding decline in the amount being eaten. Between one day and one week before oviposition, the female will either show little interest in food or completely cease eating. Behavioural signs of this disinterest include nudging the food with the snout, picking up food and then dropping it, or not being decisive about swallowing food.

Once the female has deposited her eggs and completed repacking and camouflaging the nest site, a dramatic change in her behaviour occurs. Within a day or two of completing oviposition, her interest in food becomes heightened along with her food intake. This is accompanied with behaviour indicators, such as rapid tongue flicks and a change in body language, as soon as food is offered. The re-establishment of this food drive seems to be a clear indication that oviposition has occurred. In 21 trials using this detection method, we have been 100% successful in obtaining clutches for incubation. The success of this method not only enables us to continue our successful breeding program, but also is a key part of a non-intrusive husbandry regime which we believe is necessary to the long-term well-being of the animals in our care.

ACKNOWLEDGEMENTS

Many thanks to Kelsey Engle for her support, assistance and advice, with the Qld Reptile and Fauna Park's varanid research program.

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CORRECTIONS TO IDENTIFICATION OF PHOTOGRAPHS OF 'ENDANGERED' FROGS OF THE WET TROPICS RAINFOREST

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Identifying the 'declining frogs' of the Wet Tropics rainforest (Richards et al. 1993, Pac. Cons. Biol.) is hindered by the lack of information and photographs of these critically endangered species. The problem is further confounded by publication of photographs that have been misidentified. My experience with the extant stream-dwelling frogs in the Wet Tropics rainforest, museum specimens, and the relevant literature, provides a basis for identification and I present the following corrections to the published photographs of *Litoria lorica, L. rheocola and L. nyakalensis*.

Encyclopedia of Australian Animals: Frogs. M.J. Tyler. Angus & Robertson.

The photograph cited as *Litoria nyakalensis* on page 26 is *Litoria rheocola*; characterised by the thin forearms and the inter-orbital bar.

The photograph cited as *Litoria rheocola* on page 32 is *Litoria nyakalensis*; characterised by the enlarged, robust forearms, the lack of an inter-orbital bar and the golden eye.

Reptiles and Amphibians of Australia. 1994. H.G. Cogger. Reed Books.

The photograph cited as *Litoria lorica* on page 114 is *Litoria rheocola*; characterised by the thin forearms (an inter-orbital bar and the lack of spines on the chest – on the preserved specimen).

A Field Guide to Australian Frogs. 1995. J. Barker, G.C. Grigg and M.J. Tyler. Surrey Beatty & Sons.

The photograph cited as *Litoria lorica* on page 137 is *Litoria rheocola*; characterised by the thin forearms (an inter-orbital bar and the lack of spines on the chest – on the preserved specimen).

Note: *Litoria lorica* has not been photographed but is described as similar to *L. nannotis* in appearance. I am unaware of any photographs of *Litoria lorica* from Thornton Peak. If anybody has a photograph of this frog could you please contact me as it will greatly assist in the search for the 'missing frogs' of the Wet Tropics.

These corrections are presented to clarify the current confusion in the literature and facilitate accurate identification of these endangered species in the field. Special thanks to the photographers, Harald Ehmann and John Wombey. Steve Richards helped clarify the identity of the photographs. Finally, I wish to thank the authors of the books who kindly assisted and encouraged the preparation of this note.

OBSERVATIONS ON THE EASTERN OWL FROG *HELEIOPORUS AUSTRALIACUS* (ANURA: MYOBATRACHIDAE) IN SOUTHERN NEW SOUTH WALES

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ABSTRACT

Field based studies of Eastern Owl Frogs *Heleioporus australiacus* were undertaken in the Shoalhaven region to describe their distribution, habitat preference, fecundity and behaviour. The results identify the critical habitat of this threatened species and aid in its conservation. Examination of 18 breeding sites of Owl Frogs indicated that spawning occurred in the upper sections of creeks that ran through heath or open forest adjacent to heath. The water in these creeks was acidic and many breeding sites dried during drought. Tadpoles were found at altitudes ranging between 40 – 690m. In the Shoalhaven region breeding behaviour and spawn was observed in late summer and autumn. This corresponds with the time of the year when this region receives its maximum rainfall. The largest breeding aggregation found numbered about 8 adults. Frogs called predominantly during warm nights after periods of intense rain. Spawn was located in concealed positions within creeks under organic debris. Free-living tadpoles varied in growth rate, and the time taken for metamorphosis ranged between 3 and 11 months.

INTRODUCTION

The distribution of the Eastern Owl Frog is from the Watagan Mountains (Mahony 1993) in central New South Wales to east Gippsland Victoria (Gillespie 1990, Webb 1987). Gillespie (1990) showed that populations in East Gippsland and southern New South Wales are separated from northern populations by approximately 200km (ie from Bega to Jervis Bay). In the northern portion of its range, the species occurs in hanging swamps on sandstone shelves and beside perennial non – flooding creeks (Webb 1993). In the southern end of its range the Eastern Owl Frog occurs in a wide range of forest communities including montane sclerophyll woodland, montane riparian woodland, wet, damp and dry sclerophyll forest (Gillespie 1990) and has been found at an elevation of 920m (G. Webb pers. comm.).

Tyler (1992) indicated that the Eastern Owl Frog has a population which is very sparse and probably secure. However the species is listed in New South Wales as vulnerable under the *Threatened Species Conservation Act 1995* which indicates that concern exists for the species continued survival in that state. In the Illawarra/Shoalhaven region the Eastern Owl Frog was previously known from a few records including Jervis Bay (Littlejohn and Martin 1967), 15km SE of Bowral (AM record 1963) and Bomaderry Creek (National Parks and Wildlife Service of New South Wales Database).

Lunney and Barker (1986) located a single dead specimen in Mumbulla State Forest near Bega during an intensive five year study of the areas reptiles and amphibians. Mumbulla SF is predominantly vegetated by Silvertop Ash *Eucalyptus sieberi* (pers. obs.), although the specimen was found in an area of heath and low open forest (Lunney and Barker 1986).

Male Eastern Owl Frogs call during summer and autumn from partially flooded burrows at the base of creek banks or beneath dense vegetation beside creeks and swampy ground (Gillespie 1990, Littlejohn and Martin 1967. Hoser (1989) stated that Eastern Owl Frogs often mated and spawned within Yabby burrows. Breeding is not restricted to burrows where free water is available as Gillespie

(1990) noted several instances where Owl Frogs have been recorded calling from within bodies of water (ponds and creeks) and Watson and Martin (1973) found unpigmented egg masses deposited in standing or flowing water, concealed amongst vegetation. Larval development of *Heleioporus* spp. is completed within 3 to 5 months (late spring to early summer) (Gillespie 1990, Harrison 1922). M. Mahony (pers. comm.) located breeding burrows in Galston Gorge (Sydney) which were 35 – 56 cm in length (n = 7) situated in a horizontal plane and had an enlarged chamber at the end.

In this paper I provide further information on the general biology of the Eastern Owl Frog. Descriptions are given of habitat and oviposition sites, and comments are made on this species status.

METHODS

Day searches were conducted along the upper laterals of creeks for Eastern Owl Frog tadpoles at sites in the Shoalhaven, Illawarra and southern Sydney region. If tadpoles were detected then nocturnal surveys were conducted at some sites for adults using 100 watt 12 volt spotlights to search the edge of creeks.

Tadpoles were collected using a small scoop net. Prior to netting pools organic debris and loose stones were removed. Tadpoles were flushed from loose leaves and crevices. Pools were observed for a few minutes after netting as the process stirred the water which prompted remaining animals to surface for air. Tadpoles were measured and released back into their pool. A selection of tadpoles from the dried pools at Bugong were retained until it rained and were released at the point of capture.

The areas where Owl Frogs/tadpoles were detected were Vincentia, a coastal suburb in Nowra New South Wales; Royal National Park; Jervis Bay National Park (JBNP); Morton National Park; Barren Grounds National Park; Wollongong escarpment; Sydney Water; Bugong and Helensburgh. A total of 18 sites where Owl Frogs bred were analysed for unifying features such as lithology, altitude and vegetation. These sites spanned 150km. The Vincentia site was surveyed nineteen times from mid February 1994 to May 1996 (Table 2) and Bugong at least ten times from March 1995 to May 1996 (Table 3). Two spawns were retained for study. Tadpoles were raised in a variety of tanks which ranged in volume from approximately 1-25 m^3. Temperatures were recorded on a Micronta digital thermometer and pH was recorded using a Scan 2 Eutach Cybernetics pH metre buffered at 4, 7 and 10.

RESULTS

In the Shoalhaven area, Eastern Owl Frog spawn was found in February, March and April after intense rain. Eighty-eight mm fell between 12-13 February 1994, 82mm over 9-10 March 1994 and 160mm of rain fell between the 12-19 April 1994 (rainfall records from HMAS Albatross, 17km west of Jervis Bay/Vincentia). Spawn were subsequently found on 22 February 1994, 17 March 1994 and the 20 April 1994 in the upper sections of ephemeral creeks in this region which passed through heath or tall open forest adjacent to heath. The dominant species, in areas where spawn and tadpoles were found included Blackbutt *Eucalyptus pilularis*, Silvertop Ash, Grey/Spotted Gum *E. punctata / Corymbia maculata* and Redgum *Angophora costata*.

Spawns averaged 741 eggs (n = 3, range of 698 – 807). Eggs were laid in water among the leaves of Coral Ferns *Gleichenia microphylla*, Sawsedge *Gharnia sieberiana* or organic debris and hatched 4 – 10 days after they were found. The eggs were pigmented, measured about 3 mm in length and were contained in a foam raft that floated on the surface of the water. Hatchling tadpoles measured approximately 10mm in total length and had prominent external gills. A population of tadpoles observed in the field varied in their growth rate. A size difference within a cohort

was discernible a week after hatching and this difference continued over several months. Free ranging tadpoles which hatched in late February 1994 began to metamorphose in May of that year.The minimum time interval between hatching and metamorphosis was 92 days at 13–19° C. Slow growing tadpoles were observed to over-winter and complete metamorphosis in the following spring/summer.

All sites where Eastern Owl Frog tadpoles were found had sandstone as the underlying substrate. The upper section of the creeks utilised for spawning did not contain fish, had a small gradient (approximately 1:10), possessed vegetation associated with swampy heath and contained pools which received some direct sunlight. The vegetation immediately beside the creeks frequently consisted of Sawsedge, Coral Fern and sedges *Restio* spp. Eastern Owl Frog tadpoles were found during this survey at altitudes which ranged between 40 and 690m. Man-made channels or gutters in Jervis Bay National Park, adjacent to roads were also used for spawning and had native vegetation growing along their edges. The pH of water in creeks that had Owl Frog tadpoles varied from 4.2 – 6.3 (n= 6).

Creeks populated by tadpoles occasionally experienced flood. The presence of flood debris indicated that the creek at Vincentia rose some 60cm after substantial rain on 12-14 April 1994 (Table 2). Tadpoles were subsequently observed, on 20 April 1994 up to 315m downstream, however numerous tadpoles persisted in the upper portion of the creek.

Several creeks where Owl Frog tadpoles were found dried during drought. Live tadpoles stranded in potholes or pools within the creek were found within the organic debris at the bottom of ponds. Drought caused the death of a cohort of tadpoles at Vincentia and interrupted breeding (Table 2).

Observations of tadpoles of the Eastern Owl Frog indicated that they had benthic habits and fed on algae which grew on rocks. Tadpoles are dark brown or black and when viewed under spotlight at night appear to have metallic flecking upon their lateral surface (Figure 1). They have a golden iris.

Tadpoles raised in captivity reached a maximum length of 85mm (J. Recsei pers. comm.) and metamorphlings measured up to 25mm in snout to vent length. In captivity metamorphosis can occur within 85 days (J. Recsei, pers. comm.). In the field tadpoles and metamorphlings were smaller in size with tadpoles attaining a total length of 65mm and metamorphlings 20 – 24mm (snout-vent length).

The Vincentia site possessed the largest population of adult frogs. Four adults were detected, one female and three males within the upper 100m of the creek. Four spawns were located and hence, if the sex ratio is 1:1 the site contained at least eight adults. Other sites (see below) where adults were detected appear to consist of a few animals.

Males usually call at night after intense rain but have also been heard during the day (pers. obs.). In the Illawarra/Shoalhaven breeding occurs in late summer and autumn, a period during which the region receives the greatest volume of rain. During this study calling was recorded at temperatures of 12 – 22ºC (air) and 13 - 21ºC (water). I could only hear Owl Frog calls for a distance of approximately 30 – 100m.

One calling male detected at Vincentia on 21 February 1996 beneath dead organic debris beside a pool began to exude a white sticky fluid from its back when handled (Figure 2). The secretion dried rapidly on contact with human skin and was difficult to remove. The frog began to emit a distress call which was a high pitched repeated 'wehh' as it crawled away.

Table 1 Description of sites where Eastern Owl Frog tadpoles were found

Location	Vegetation	Observation
Royal National Park Two sites found Lat 34° 11' Long. 151° 02' Elevation 180m	Woodland/open forest adjacent to heath: *Angophora costata* *Eucalyptus racemosa/haemastoma* and *E. Sieberi.* Understorey: *Ceratopetalum gummiferum, Tristania neriifolia, Banksia ericifolia, B. serrata Telopea speciosissima, Xanthorrhoea* sp, and *Doryanthes excelsa* Groundcover: *Gharnia sieberiana, Gleichenia microphylla* and Bracken	Two breeding sites were located on 16/3/94 by the presence of tadpoles in the upper section of separate creeks.
Helensburgh One site found Lat. 34° 10' Long. 150° 49' Elevation 180m	Open forest: *Eucalyptus racemosa/haemastoma* E. sieberi Understorey: *Allocasuarina litorialis, Banksia ericifolia, Persoonia linearis, Kunzia ambigua* and *Gleichenia microphylla*	On 4/2/96 tadpoles were found in a 4m x 1m x .15m pool and another 5 in a 3m x 0.6m x 0.1m pool. Tadpoles of two size classes one 58mm and another 30mm total length. pH 4.3
Sydney Water One site found Lat. 34° 21' Long. 150° 49' Elevation 400m	Open forest: *E. sieberi, E. sclerophylla, Leptospernum polygalifolium, Bauera microphylla, Gharnia sieberiana* and sedges	On 26/7/95 tadpoles were found in the upper section of a creek by P. German. Yabbies present.
Mount Kembla One site found Lat. 34° 27' Long. 150° 42' Elevation 480m	Open forest: *E. sieberi* which had an understorey of *Gleichenia microphylla*, and *Todea barbara Acacia ulicifolia, Gharnia* spp., *Leptospermum* sp *Melaleuca* sp and *Baeckea linifolia.*	In 1994 L. E. Smith found tadpoles. During February 1995 he detected an adult male and a female close to the site crossing a road. No tadpoles found in March 1995
Barren Grounds National Park One site found Lat. 34° 41' Long. 150° 42' Elevation 590m	Heath: *Banksia paludosa, Banksia robur Hakea teretifolia*, sedges and *Gleichenia microphylla*	2/11/93 four males were heard calling from within Yabby burrows beside a small creek during the day immediately after an intense downpour.
Red Rock Nature Reserve One site found Lat. 35° 47' Long. 150° 33' Elevation 580m	Heath: *E. sieberi* which had an understorey of *Banksia serrata, Gleichenia microphylla*, and *Todea babara* lined the creek. The area had been burnt in the previous year.	17 April 1996 20 tadpoles in a single pool 4 x 3 x 0.5m deep. Temp. 11.9°C (Water)

Bugong Three sites located Lat. 34°49' Long. 150° 28' Elevation 180 – 200m	Site 1 Open forest adjacent to heath/woodland: *E. punctata, Syncarpia glomulifera* Understorey: *Kunzia ambigua, Banksia spinulosa* and *Melaleuca linariifolia.* Ground cover: *Gharnia sieberiana, Gleichenia microphylla.* Site 2: Open forest adjacent to heath Site 3: Open forest adjacent to heath	Tadpoles detected on 19/7/94 at Site 1. 72mm of rain fell between 1 – 6/3/95 and two males were heard calling from within clumps of *Gleichenia microphylla* on 6/3/95. No tadpoles or adults detected in 1995 or 1996. Details of Sites 2 and 3 are given in Table 3.
Vincentia One site located Lat. 35° 05' Long. 150° 41' Elevation 40 – 50m	Tall open forest adjacent to heath: *Eucalyptus pilularis, Corymbia gummifera, Banksia serrata* and *Ceratopetalum gummiferum* Groundcover: *Gharnia sieberiana, Gleichenia microphylla* and sedges.	See Table 2 for details
Jervis Bay National Park Three sites located Lat. 34° 09' Long. 150° 42' Elevation 40 – 70m	Heath: *Allocasuarina distyla, Banksia ericifolia, Hakea teretifolia, Xanthorrhoea australis,* sedges and *Corymbia gummifera.* Groundcover: *Gleichenia microphylla, Gharnia sieberiana* and sedges	21/3/94 two spawns found 10m apart under dense vegetation within the creek at the site where a pair of adults were detected on 17/3/94. Tadpoles found in two other culverts.
Morton National Park Four sites located Lat. 34° 11' Long. 150° 15' Elevation 620–690m	Heath similar to above site but included *E. consideniana.*	2/5/94 tadpoles detected in four creeks. One site possessed about 35m of creek which was suitable for tadpoles as it terminated in a waterfall.

The Vincentia and Bugong sites were studied in detail and results are presented in Tables 2 and 3. At Vincentia no Yabbies or fish were detected in the section of the creek that had Owl Frog tadpoles, however 300m downstream the Common Jollytail *Galaxia maculata* a native species of fish, were present. Other frog species present were the Common Eastern Toadlet *Crinia signifera* and the Brown Toadlet *Pseudophryne bibronii.*

Table 2 Summary – Vincentia Study Site

Date	Observation / Event
September 1995	Owl Frog tadpoles observed in creek.
late January 1994	Upper portion of creek dry. No tadpoles found.
12 – 13 February 1994	88mm of rain fell at HMAS Albatross.
15 February 1994	2 males (1 calling) and 1 female found at night. Temp. 22°C (air), 18.7°C (water).
22 February 1994	Spawn no. 1 detected in creek under debris.
26 February 1994	Unfertilised eggs observed in pool no. 1, below logjam/Coral Fern/Sawsedge
4 March 1994	Hatchlings observed in pool no. 1.
9 – 10 March 1994	82mm of rain fell at HMAS Albatross.
12 March 1994	No males heard calling during the day. Temp. 10°C (air).
15 March 1994	One male calling during overcast day. Temp. 16.4°C (air), 18.7°C (water).
2 April 1994	Two males calling during the day 9.00 hrs EST. Temp. 19.7°C (air). A new cohort of hatchling tadpoles observed in pool no. 1
12 – 14 April 1994	156mm of rain fell at HMAS Albatross.
20 April 1994	Spawn no. 2 detected in Coral Fern. Tadpoles from 4/3/94 observed downstream 315m from oviposition site.
11 May 1994	Tadpoles with front legs.
27 May 1994	Area burnt.
29 May 1994	One male calling from logjam above pool no.1. The Coral Fern/Sawsedge was unburnt. 1400 hrs EST. Temp. approximately 22°C (air).
30 May 1994	Metamorphling measured 24mm.
9 June 1994	One male calling from spawn site no.2. Temp. 12.1°C (air), 13.3°C (water)
2 – 4 January 1996	50mm of rain was recorded at Nowra.
31 January 1996	Several hundred small (20mm) tadpoles seen in pool no. 1. Large tadpoles were present from the previous years breeding effort.
21 February 1996	A calling male heard and tadpole with back legs observed. Temp. 18.4°C (air) 20.4°C (water).
28 February 1996	*Crinia signifera* and *Pseudophryne bibronii* calling. Temp. 20.1°C (air), 20.8°C (water).
3 April 1996	Upper portion of creek had dried. Two tadpoles detected in pool some 100m downstream from pool no. 1. Temp. 18.7°C (water).
11 – 13 April 1996	83mm of rain fell at HMAS Albatross.
2 – 6 May 1996	90mm of rain fell at HMAS Albatross.
7 May 1996	One male calling 500m from creek. Temp. 16.6°C (air), 17.2°C (water). Small tadpoles about a week old observed up to 60m downstream from pool no. 1.

Owl Frogs were heard calling at Bugong (Site 1) once during a minimum of ten nocturnal searches during the breeding season. Other species of frog detected at this site included the Blue Mountains Tree Frog *Litoria citropa*, Bleating Tree Frog *L. dentata*, Lesueur's Tree Frog *L. lesueurii*, Peron's Tree Frog *L. peronii*, Verreaux's Tree Frog *L. verreauxii*, Common Eastern Toadlet *Crinia signifera*, Brown Toadlet *Pseudophryne bibronii*, and Tyler's Toadlet *Uperoleia tyleri*. Several of these species bred in the creek utilised by Owl Frogs.

Table 3 Summary – Bugong sites 2 and 3

Date	Site	Pool Size (m)	No. of Tadpoles	Observation
11 March 1996	2, Pool1	1.5 x 1.0 x 0.6 deep	20	Creek not flowing. Temp. 16.6ºC (water)
28 March 1996	2, Pool1	wet mud and debris	24	Pool had dried and tadpoles found lying in mud under rock. A metamorphling measured 20mm (s-v) and 40mm (t-l)
11 March 1996	2, Pool 2	1.5 x 1 x 0.1 deep	1	
28 March 1996	2, Pool 2	0.2 x 0.2 x 0.1 deep	none	Pool had dried to a puddle. The average length of tadpoles from site 2 measured 20.6mm (snout–vent) and 51mm (total length) (n=46)
28 March 1996	2, Pool 3	0.3 x 0.2 x 0.1 deep	24	Tadpoles hid under leaves
2 April 1996	site 2		none	Pools 1, 2 and 3 dry
5 June 1996	site 2	creek flowing	none	No Owl Frog tadpoles found. Temp. 10.9ºC (water).
28 March 1996	3, Pool 1	0.9 x 0.4 x 0.13 deep	8	Creek not flowing. Temp. 16.9ºC (water)
2 April 1996	3, Pool 1	Puddle	6	Tadpoles stranded in residual water
28 March 1996	3, Pool 2	0.6 x 0.4 x 0.06 deep	6	The average length of tadpoles from site 3 was 15mm (s-v) and 37mm (t-l) (n=15)
2 April 1996	site 3	No free water	none	No tadpoles found.
28 March 1996	3, Pool 3	0.8 x 0.5 x 0.15 deep	2	One metamorphling measured 20mm (s-v) and 51mm (t-l). + one tadpole. Temp. 20.2ºC (water)
2 April 1996	3, Pool 3	0.3 x 0.5 x 0.05 deep	1	One tadpole with portion of tail missing
5 June 1996	3, Pool 2	3 x 0.5 x 0.05 deep	hundreds	Tadpoles only in one pool at site 3. Temp. 13ºC (water). Length of tadpole 9mm (s-v), 22mm (t-l).

Note: Length (s-v) = snout to vent
(t-l) = total length

DISCUSSION

Gillespie (1990) indicated that a distance of 200 km separates the known populations of Owl Frogs in NSW (ie. from Bega to Jervis Bay), however during surveys of Narooma State Forests in 1994 a single animal was seen (Wellington and Wells 1994), narrowing the distance between known populations to 100 km (Bega to Narooma). Thus, it is probable that populations of Owl Frogs are continuous from northern Victoria to central New South Wales. The lack of information on the species may be due to the paucity of surveys in southern New South Wales, and the fact that Owl Frogs are difficult to detect.

Even though the species may be continuously distributed there is still the possibility that there are two geographically isolated races. This suggestion is based on the southern population having a wider habitat preference and, eggs located in the Shoalhaven being pigmented whereas Watson & Martin (1973) state eggs at Walhalla in Victoria were unpigmented.

Eastern Owl Frog tadpoles are unspecialised (Watson & Martin 1973) and do not possess the large dorsally orientated mouth of other creek breeding frog species such as

Lesueur's Tree Frog *L. lesueurii*, Blue Mountain Tree Frog *L. citropa* and the Stuttering Frog *Mixophyes balbus* (pers. obs.). Eastern Owl Frog tadpoles have not been observed to hold the substrate in a manner similar to the above mentioned species but were not flushed down the creek at Vincentia or Royal National Park after an intense localised flood. Tadpoles of the Eastern Owl Frog do disperse shortly after hatching (pers. obs.) and the majority of tadpoles occur within 100m downstream of where they hatched.

The morphology of Eastern Owl Frog tadpoles is similar to that of three members of the Limnodynastini tribe, the Eastern Banjo Frog *Limnodynastes dumerili*, the Brown-striped Frog *L. peroni* and the Spotted Grass Frog *L. tasmaniensis* (pers. obs.). In southern Victoria and Tasmania, Brown-striped Frogs lay unpigmented eggs (Littlejohn 1963). In Victoria these eggs could be confused with those of the the Eastern Owl Frog. However the Eastern Owl Frog eggs are distinct as they measure 2.6 mm in diameter (Watson & Martin 1973) which is almost twice the size of any other east coast Myobatrachidae that lays its eggs in a frothy mass (Tyler 1989; pers. obs).

The observation made here that these tadpoles can survive in a small volume of water when their pond dries indicates that they may be advantaged by the presence of Yabby burrows. These burrows may serve as refuge sites during drought as they form a labyrinth of holes at the watertable (pers. obs.).

The observation that tadpoles can metamorphose between 3 and 12 months indicates that there is an advantage in staggering the growth rate. Individuals from a single cohort will metamorphose at various times during the year and hence are subjected to a variety of weather conditions.

Three spawns were located some nine days after substantial bouts of rain. I have observed that many amphibian species breed after the cessation of rain (Daly 1995a; unpublished data). Owl Frogs seem to spawn when the water level within creeks begins to drop.

The number of tadpoles per spawn recorded by Watson and Martin (1973) ranged from 775 – 1239 (n=4). These figures are higher than those reported here (698 – 807) but indicate that the Eastern Owl Frog has a moderately small clutch size compared to its body size (pers. obs.) and this trend is consistent within the *Heleioporus* genus (see Tyler 1989). The fact that *Heleioporus* spp. have such large eggs (Tyler 1989) may account for the relatively low number which are laid.

Knowledge on the dispersal movements of Owl Frogs is inadequate. Pitfall trapping indicated that animals do move through eucalypt forest (Webb 1987, 1991; K. Roberts unpub. data). Many creeks which I surveyed did not possess Owl Frog tadpoles even though the habitat appeared suitable and populations existed nearby. The small number of animals that constitute breeding groups and the patchy nature of these groups is atypical for east coast Australian frogs (pers. obs.). Even though the majority of adult frogs were found in association with breeding sites animals do disperse over dry sandstone ridges (Webb 1983).

One Owl Frog exuded a fluid and emitted a loud high pitched cry. The secretion covered the back of the animal and looked superficially like that emitted from Cane Toad *Bufo marinus* parotoid glands. The fluid dried rapidly on contact with human skin. The frog cried while it secreted fluid. This behaviour is designed to repulse potential predators. I have heard Green Tree Frogs *L. caerulea* and Rocket Frogs *L. nasuta* cry in a similar way when distressed.

Conservation of habitat is essential for this species survival. No specimens have been detected from cleared lands (Gillespie 1990; pers. obs.) and the species appears to be dependant on areas which contain native vegetation. Hence, urban expansion in many areas of the Sydney basin is impacting upon the species. Roads may also have an impact on Owl frogs which are slow moving and would be more susceptible to being hit by vehicles than faster moving species.

Figure 1

Heleioporus australiacus Length (s- v) 25mm (t - l) 61mm

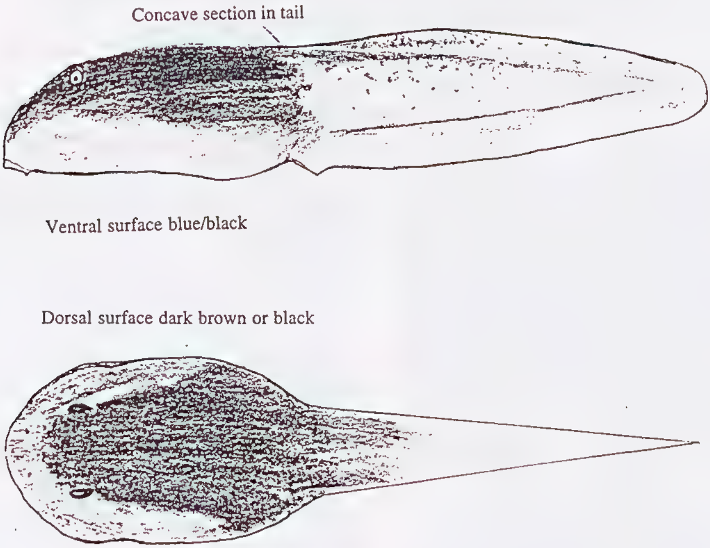

Figure 2

The need to protect Owl Frog habitat is acknowledged by the New South Wales National Parks and Wildlife Service. Currently there is a proposal to include the Vincentia site in Jervis Bay National Park. The sites on Crown Land at Bugong has been referenced for inclusion to Morton National Park (D. Andrews pers. comm.).

The preservation of Owl Frog habitat will aid the survival of other species listed as threatened in New South Wales. At several of the study sites (Morton NP, JBNP and Barren Grounds NP) the Owl Frog is sympatric with the Bristlebird *Dasyornis brachypterus*, Ground Parrot *Pezoporus wallicus* and White-footed Dunnart *Sminthopsis leucopus* (JBNP and Bugong Crown Lands) (King 1980, Daly 1995b, Daly and Murphy 1996). These species are highly associated with coastal heath.

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AN OBSERVATION OF AGGREGATION BEHAVIOUR BY TADPOLES OF THE GREAT BARRED RIVER FROG (*MIXOPHYES FASCIOLATUS*)

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Water bodies in Chaelundi State Forest were surveyed for frogs in late 1993 as part of an Environmental Impact Statement for State Forests of NSW (see Lemckert, 1995). At 9.30 pm on the evening of the 27th September a large number of tadpoles were observed tightly clustered within a metre of the bank of a large stock watering dam adjacent to Chaelundi Forest Road (AMG 442850 6689100). The cluster had formed between patches of emergent grass in about 10cm of water and consisted of an estimated 300 tadpoles of varying size gathered in a mass approximately 50cm long, 30cm wide and some 5 to 10 tadpoles deep. All were motionless with their heads orientated towards the bank and they appeared to be packed together as tightly as possible. Further inspections located a second smaller cluster of tadpoles (30cmx20cm) in a similar situation within a metre of the first group. Both groups began to break up after being illuminated, with individuals moving off in rapid, short bursts. Within five minutes of the removal of the light source the tadpoles began to reform into clusters. The following day the site was revisited to collect tadpoles for description and identification. At this time the aggregations had dispersed and instead, the tadpoles were extremely active with individuals moving off very rapidly when approached, often appearing to "skip" along on the surface of the water.

The individuals that were collected were of varying size, the largest were approximately 10.5cm in total length and approximately 3cm across at the widest point of the body. Their body in general was a dark olive-green to brown and the fins unpigmented. They were identified as tadpoles of the Great Barred Frog (*Mixophyes fasciolatus*; G. Daly, pers. comm.), the adults of which were common throughout the area. The dam itself was approximately 20m in diameter and more than 2m deep in the centre with a muddy bottom and the surrounding vegetation was a dry sclerophyll forest dominated by spotted gum (*Eucalyptus maculata*) with a generally open understorey. There were occasional patches of grass in and along the waters edge and some disturbance by cattle was noted. In fact, the tadpoles were noted to be eating cow pats which had been deposited in the dam water.

Clustering activity has previously been noted to occur with northern Australian tadpoles (Tyler 1989), but there are apparently no reports in the literature of such behaviour for southern temperate tadpoles. Duellman and Trueb (1986) present three possible explanations as to why the tadpoles would form such a cluster. Firstly, tadpoles may aggregate in order to increase feeding success by stirring up more nutrients. There was no indication of feeding activity at the time of observation, so this appears an unlikely explanation. Secondly, tadpoles may cluster to reduce predation and, in this case, the noted aggregations of individuals would likely provide a large and confusing image to eels and tortoises which are the most probable nocturnal predators. This would be especially so when there is a sudden scattering of individuals, as did occur, and this appears a quite plausible explanation. Thirdly, tadpoles may cluster in areas which contain either cooler or warmer water. Unfortunately, water temperatures were only taken at the edge of the pond (15°C) and so it cannot be ascertained if the water temperature varied significantly in different areas. However, it is highly likely that the water temperature in the shallows was

warmer than in deeper parts of the pond, at least for the early part of the night, and individuals present there would have been capable of quicker responses to threats of predation and also have a faster digestion of any food in their gut. Therefore, it would appear reasonable to suggest that the tadpoles may have formed aggregations to present a more difficult target for predators and additionally clustered in the shallows so as to further increase the chances of avoiding predators as well as increasing growth rates. A return to the site to measure water temperatures at various points in the dam should help to understand what advantages may be gained by such behaviour.

ACKNOWLEDGEMENTS

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AN UNUSUAL BEHAVIOUR IN THE AGAMID *TYMPANOCRYPTIS LINEATA* ON THE BARKLY TABLELANDS

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On the second of October 1994, while crossing the black soil plains of the Barkly Tablelands just on dusk and for the first few hours after dark more than 20 *Tympanocryptis lineata* were seen on the road in the headlights of the car. The road was still moist as it had rained about an hour before dark. Air temperature was estimated to be in the mid 20's and very still with no breeze. A couple of the *T.lineata* were active on the road but most (about 16) were in a crouched position and inactive. Initially we stopped for three which were found to be dead but were not picked up. After driving a few kilometres further it was decided to take some of the *T.lineata* corpses back to NTU to be used in dissection and preservation studies. Three animals were located which were on their back and thought to be dead. When we attempted to pick them up we found them very much alive. All three animals were female and gravid. Although not measured, the air and ground temperature appeared similar, indicating that thermoregulation may not be an adequate explanation for the behaviour. No males were observed in this position, although only the three animals which we found on their backs were sexed at the time. Subsequently two of three corpses collected were male. The total number of dead animals was estimated at 7, but the animals collected had been dead for some time with rigor mortis having set in.

This behaviour may be similar to the belly up position exhibited by gravid pythons (pers. obs.). Why they would choose a dark road to expose their extremely white ventral surface is perplexing. This would make them vulnerable to attack from predators and increase their reflex time. Another possibility is that another car or truck had created a large downwind as it passed over the animal. This may mean the animals were tumbled down the road and left in a stupor, remaining on their back until being handled, upon which they regained consciousness. This is difficult to reconcile as we only saw one vehicle in the two and a half hours it took for us to cross the Allroy-Brunette section of the Tablelands highway and that vehicle was within two kilometres of us finishing the trip. This was an unusual behaviour for which it is difficult to ascribe some ecological significance.

RELICT HERPETOFAUNA OF A SMALL BUSHLAND REMNANT IN SYDNEY, NSW

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Lane Cove Bushland Park and the adjoining Gore Creek Reserve are located on the lower north shore of suburban Sydney, four kilometres north-west of the city centre. Together they comprise approximately fifteen hectares with vegetation ranging from low closed forest along the Gore Creek watercourse to open sclerophyll forest on the higher slopes. Rock outcrops of Hawkesbury sandstone are common. The reserves have suffered considerable infiltration by exotic weeds, and the creek is frequently visibly polluted by urban run-off. Nevertheless significant natural habitat still exists. Observations of the reptiles and amphibians occurring there were made between 1990 and 1993. Field work was conducted in all seasons and included both diurnal and nocturnal observation. The list of species recorded is presented here as an example of the herpetofauna surviving in a typical small bushland remnant in the greatly modified inner Sydney urban area.

Saproscincus galli is the current name (Sadlier *et al*, 1993) for the species formerly included in the composite *Saproscincus challengeri* (Swan, 1990). This species was recorded in the low closed forest in Lane Cove Bushland Park and was partly arboreal in habit, one skink being observed on the trunk of a tree fern two metres above the ground.

Most of the species listed above, and two additional species, *Ctenotus taeniolatus* and *Eulamprus tenuis*, were also observed in urban gardens in the surrounding area. It was concluded that this small bushland remnant was of insufficient size to have functioned as a significant refugium for the area's original herpetofauna. Species lost from the reserves, based on consideration of range and habitat, probably included *Heleioporus australiacus*, *Chelodina longicollis*, *Varanus varius*, *Morelia spilota*, *Demansia psammophis* and *Pseudonaja textilis*.

Table 1. Species recorded in Lane Cove Bushland Park and Gore Creek Reserve.

Hylidae
Litoria phyllochroa
Myobatrachidae
Crinia signifera
Limnodynastes peronii
Agamidae
Physignathus lesueurii
Scincidae
Cryptoblepharus virgatus
Eulamprus quoyii
Lampropholis delicata
Lampropholis guichenoti
Saproscincus mustelinus
Saproscincus galli
Tiliqua scincoides

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OBSERVATIONS OF GROOMING IN SOME CAPTIVE AUSTRALIAN CHELID TURTLES

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Grooming behaviour is described by Legler (1978) and Cann & Legler (1994) in three Australian chelid turtles, *Chelodina expansa, C. longicollis* and *Rheodytes leukops*. Grooming involves the turtle biting at its limbs to remove dead skin whilst in the water (Legler, 1978). This behaviour has not been recorded in any other Australian chelid. Here I record the carapace length (CL) and describe grooming behaviour by an additional four species of chelid turtles under captive conditions. The *Chelodina spp.* were also found to groom more regularly than the short-necked turtles in this study.

Grooming was observed in *Emydura macquarii, Chelodina rugosa, C. expansa* and *C. longicollis* where captive conditions did not provide any land area or basking platforms for the turtles to leave the water. Juveniles of *E. macquarii* were observed to remove dead skin from their feet by biting at the skin, and to use their front claws to scratch or rake loose flaking skin from their neck. These chelids grew from hatchlings to 150 mm (CL) and were noted to groom throughout this period. Juvenile and adult *C. rugosa* (CL 50-280 mm), *C. expansa* (CL 50-300 mm) and *C. longicollis* (CL 30-200 mm) were noted to groom by biting at the loose skin, with *C. rugosa* being the more predominant of the *Chelodina* species to groom.

Grooming behaviour was also observed during the cooler periods of the year (May–Aug.) in *Elusor macrurus, Emydura macquarii, E. kreffti, Chelodina expansa* and *C. longicollis* where a land area or basking platform was provided but not used by the turtles. The temperature, while still cold (11–14°C), was not low enough for the turtles to be in a complete state of winter dormancy. All turtles were housed in glass aquariums and received a natural photoperiod via two skylights and a fluorescent light suspended above each aquarium. These turtles were not provided with heat lamps for basking over the Victorian winter, hence they did not atmospheric bask during this period to maintain skin and shell condition or assist ecdysis (Chessman 1987). *Elusor macrurus* (CL 150-200 mm) were observed to remove dead skin from the posterior part of the forelimbs by repeatedly biting at the skin. The dead skin appeared to be ingested as the resulting bites were not followed by the spitting out of any skin. Adult *E. kreffti* CL= 200 mm were observed to scratch the inside of the rear leg with the claws of the other rear foot. Unlike the *Chelodina spp.* who use their long necks to reach the rear limbs, the short–necked turtle is restricted by the length of its neck and will rely on the claws of the nearest limb to reach these areas. *Chelodina expansa* CL= 50 mm, *C. longicollis* CL= 30 mm and *Emydura macquarii* juveniles CL<= 40 mm were also observed to groom themselves by repeatedly biting at the skin.

Webb (1978) showed that *Chelodina spp.* rarely emerge to bask, thus having a highly aquatic mode of existence, while short-necked turtles bask regularly. Where land is not provided in an aquarium the short–necked turtle is forced into a highly aquatic mode of existence, likewise, during the cooler part of the year where the temperature is too cold for basking, the turtle is also confined to the water. It has been during this highly aquatic mode that grooming has been observed by the author and confirms Legler's (1978) statement "grooming could be an aid to non–basking chelonians in keeping the skin in good condition and may be an adaption to a highly aquatic mode of life."

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A RANGE EXTENSION FOR THE DRAGON *DIPORIPHORA PINDAN*

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Two specimens of *Diporiphora pindan* were located in the Great Sandy Desert during July 1993. One of these specimens is lodged in the N.T. Museum. The localities are well outside the previously published range for this species in available publications, including Storr *et al* 1983. The first specimen was located adjacent to Joanna Spring at 20°05'07"S and 124°11'40" E at 11 a.m. on July 14. It was sitting in a low Halosarcia sp. bush on an evanescing claypan that had been invaded by grasses, *Acacia stipiligera* and *Melaleuca glomerata*. The temperature was 25° celsius on a fine clear day. The *D. pindan* was 41 mm snout vent length and 136 mm total length. It had 5 blackish stripes over the throat, the central stripe extending onto the chest where it divided to run down either side of the belly to the vent. Another thin blackish stripe ran between this divided stripe. The second specimen was caught in a swale between dunes on July 16 at the map position for Discovery Well at 20°13'32"S, 123°56'34"E. Vegetation consisted of scattered *Eucalyptus chippendalei* and stunted *Erythrophleum chlorostachys*, numerous *Grevillea eriostachya, Acacia platycarpa, A.stipiligura* and *A.tumida* (Jessop 1981) growing among Triodia of fairly poor condition. The area appeared to have been burned within the past 5 years. This specimen was found at c. 11.30 a.m. on a cool windy morning with a temperature of 20° celsius. The dragon had been perched about 20 cms above ground level on a piece of dead branch that lay on the ground among Triodia clumps. This second animal was of similar pattern and body dimensions to the first. Both localities are over 150 kms S of the southern limit delineated on distribution maps for *D.pindan* in Cogger (1992), Ehmann (1992), Storr *et al* (1983) and Wilson and Knowles (1988). In Western Australia both *A.platycarpa* and *A.tumida* are referred to as "Pindan", as is the scrub community in which they grow. When travelling north, toward Joanna Spring, pindan acacias began to appear in the central northern portion of the Great Sandy Desert, from around 21° S (pers. obs.). They become considerably more common, in the plant communities of both swales and dunes, by 20°20' S.

Diporiphora pindan appears to inhabit the northern Great Sandy Desert where this vegetation type exists.

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TWO LIZARDS AND A FROG OCCUPYING MULTIPLE SHELTER SITES WITHIN A HOLLOW TREE

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INTRODUCTION

A variety of reptile and frog species have been documented sharing the same cover (Rankin, 1975; Hoser, 1980; Maryan and Robinson, 1987; Orange, 1992; Valentic, 1993). This report details the discovery of *Varanus timorensis similis*, *Pseudothecadactylus australis* and *Litoria caerulea* utilising separate hollows within a single standing Melaleuca.

OBSERVATION

Location: Cape Weymouth, Cape York Peninsula, North Queensland (12°7'S, 143°26'E).

Habitat: Gently sloping Melaleuca woodland with a dense speargrass understorey and scattered low granite outcroppings.

Date: 17 May 1993. Time: 11:40-12:20 hours (Eastern Standard Time). Weather conditions: 28°C, heavy (100%) cloud cover, slight sea breeze.

Notes: These observations were made whilst participating in the Cape York Peninsula Land Use Study under Iron Range Zoologist in charge, Luke Leung. We located a *Pseudothecadactylus australis* in a standing dead tree (*Melaleuca viridiflora*, diameter at breast height 45 cm, total height 5 metres approx.) by tapping on numerous tree trunks as described by Cameron and Cogger (1992). We decided to dismantle the tree in order to measure and photograph the gecko. The lizard (a male, SVL:107 mm) could be heard vocalising within a hollow branch 2.1 metres above ground level. The sectioning of this branch facilitated viewing inside the main trunk where an adult *Varanus timorensis similis* (SVL:246 mm) was discovered (about 2 metres above ground level). The cavity within the main trunk steadily narrowed and a subadult *Litoria caerulea* (S-A:56 mm) was also discovered utilising a tight recess 320 mm above the varanid's position.

DISCUSSION

V.timorensis similis forage widely in search of arthropods and small vertebrates (Wilson and Knowles, 1988). It is possible that the varanid was disturbed whilst in the process of investigating the hollow for potential prey. In this case it is doubtful that the varanid would be successful due to the restricted diameter of the hollows occupied by *P.australis* and *L.caerulea*. The narrow space would effectively exclude the bulk of the varanid. If all three species were in fact sharing the tree this may indicate a scarcity of arboreal refugia in the immediate area. *Litoria caerulea* and *P.australis*, being nocturnal, may not usually be vulnerable to predation by a diurnal varanid while active and could possibly cohabit the tree with little risk of predation.

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FURTHER ADDITIONS TO THE HERPETOFAUNA OF THE MOSSMAN GORGE SECTION OF DAINTREE NATIONAL PARK, QUEENSLAND

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Mossman Gorge is one of the few areas in the wet tropics for which a comprehensive herpetofaunal species list exists (Torr, 1993). However, the survey from which this list was compiled was relatively brief and it was anticipated that further species would be added over time. The survey also did not include comprehensive sampling of the Mossman River and indeed, the first addition, that of the saw-shelled turtle (*Elseya latisternum*) came from this area (Green and Turner, 1994).

The continuation of field work in the gorge has led to the discovery of several further species. As predicted, the small-eyed snake (*Rhinoplocephalus nigrescens*) has now been recorded in the gorge. A single specimen was observed in late September, 1994, crossing the tourist trail at night.

The spotted tree monitor (*Varanus timorensis*) has been observed in the adjacent Aboriginal reserve and several tentative sightings have also been made in the National Park. There are also anecdotal reports of lace monitors (*Varanus varius*) in the Aboriginal Reserve (S. Lawler, pers. comm.) and in the rainforest at the nearby Silky Oaks resort, so their presence in the National Park seems likely.

In addition, the three species of snake (the common tree snake, *Dendrelaphis punctulata*, brown tree snake, *Boiga irregularis*, and common blacksnake, *Pseudechis porphyriacus*) not recorded in the survey but reported by one of the gorge rangers have now been observed in the National Park by the author.

ACKNOWLEDGEMENTS

Thanks to K. Brown and Mossman rangers for their continued support.

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ROAD KILL PREDATION BY THE LONG-NECKED TURTLE *CHELODINA LONGICOLLIS* (SHAW)

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INTRODUCTION

Chelodina longicollis is an opportunistic carnivore, and is generally believed to eat only in the water. The eating of carrion in the water has been recorded in a number of studies (Chessman 1984, Georges, Norris & Wensing 1986). There appears to be no record of road kill predation by *C. longicollis* or any other chelid.

OBSERVATION

On 12 October 1994 just south of Brisbane at 9.00 am on a humid, overcast morning I observed a *C. longicollis* (22 cm shell length) feeding on a road killed European hare (*Lepus capensis*). The hare was approximately 2.5 m to the side of the road and had been there for three days.

The turtle bit flesh and ripped it with the two front feet. Small dried pieces of meat were torn off and swallowed. This feeding was observed for 105 minutes. One hundred metres away there was a large man–made lagoon, approximately 350 m in diameter. The lagoon is normally about 150 cm deep when flooded, but due to lack of rain in the area for some years the lagoon was only 60–70 cm at its deepest point. While walking around the edge of the lagoon I observed dead and dying water weed, shells of various crustaceans, another 13 live *C. longicollis* and four *C. longicollis* shells. These shells measured between 23 cm and 27 cm. No juveniles were found.

ACKNOWLEDGEMENTS

Thanks to Darren Green for making available various published papers and the additional help with the manuscript.

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BOOK REVIEW

'A guide to stream-dwelling frogs of the wet tropics rainforests'

J. M. Hero & S. Fickling 1995

Department of Zoology, James Cook University, Townsville

This is a handy, little (100 x 140 mm) book that fits into your pocket. It is excellent for taking into the field. That is, if you just want to identify the thirteen species of stream-dwelling frogs of the rainforests of the Wet Tropics (but there is a good reason for this). It has a good two-page key and a page of text per species. The text covers 'Status', 'Distribution', 'Habitat', 'Description', 'Call', 'Breeding and larvae' and 'References'. There is also a colour photograph for each species (except for *Litoria lorica*, which, apparently, was never photographed before its disappearance). Overall, the booklet works very well and fulfills the reason for its publication – that of providing a handy field guide to the missing or declining frogs of the Wet Tropics. However, remember, there are about another 43 species of frogs in the region that are not covered.

But don't let that worry you. Just buy a copy and get out there and see if you can find those missing frogs, darn you.

Glen Ingram.

BOOK REVIEW

'Python'

Pauline Reilly, illus. Will Roland

Kangaroo Press, 0 86417 698 8

Series Picture Roo, Level Lower Primary, KLA Science & Technology

The snake is a perennial symbol of evil cunning and power. However there is nothing evil in this presentation, the life cycle of the python gently unfolds and any previous fears we had for our own safety from snakes are dispelled as we are shown how to live with our reptile companions.

This is an attractively presented, easy to read book packed with information. It is a factual recount in a narrative style. The text reads like a diary with the language more like that used in fiction books.

While enjoying reading about the events in the snake's life, the reader will unknowingly acquire much factual information about an Australian bush animal. There are lots of interesting details for the child to examine and

from which to learn.

It contains a lot of information presented for the most part as adventures in the life cycle of the python (23 pages) and also as facts after the story (6 pages), clearly set out in point form and containing a diagram. These are brief but informative sections. These facts contain some biological information about snakes and a guide to clarify some common misconceptions about snakes. Consequently the beneficial by-products of this book lie in reducing the readers fear of snakes, and how humans and snakes can coexist in harmony. The strength of the book is that when talking about snakes in general, it has already described the life of a particular species (python) which makes them both relate to each other.

Each page is accompanied by colourful line drawings. They add to the readers understanding of the stage of life which the python is experiencing. The colours chosen for this book match the python's natural environment. It follows the styles of others in the series described as telling the life story of birds and other animals of Australia and New Zealand. They have been crafted very neatly for their readership. Children are encouraged to respect snakes, not to fear them. The book will appeal to both the snake lover and the inquiring reader. The language layout and illustrations make the book very suitable for the beginning and independent readers (6-8 years).

A short easy to handle book attractively produced and strongly bound, illustrations and headings are bright and presenting a subject, not always endearing to everyone, in an interesting and endearing way.

In using this information resource readers need to be aware that there are no contents, index, glossary or reading list. It would be useful in a junior school library or classroom where it would be balanced by other sources with more retrievable information.

Jane Webber

BOOK REVIEW

'A guide to the Reptiles and Frogs of the Perth Region'

Brian Bush, Brad Maryan, Robert Browne-Cooper and David Robinson

University of Western Australia Press, 1995

This book is a fine team effort. It promotes a sense of satisfaction and pride in the strides that have been made by amateur herpetologists in the West. Congratulations to the authors for their persistence in building on the pioneering work of their mentor and that doyen of Western Australia herpetology, Glen Storr (to whose memory they dedicate this comprehensive field guide). They have produced a most impressive work and the only regional field guide yet for any major city in Australia.

The book has a concise introduction, a good 'using this book' chapter, and an excellent chapter (with photographs) of the Perth region's habitats. A restrained chapter on conservation includes the authors' concerns about the effectiveness of current policies and enforcement by their state's fauna authorities. Conservation policies and implementation practices which alienate significant numbers of the amateur naturalists do have a nett-negative effect on the conservation ideals of our society as a whole. Adverse policies and practices need to be re-evaluated and modified quickly and with full consultation so that these informed and involved members of society continue to support the underfunded ideals.

The heart of the book are the species accounts. These are organised under brief general overviews of the reptile and frog families (or a higher grouping), and identification keys are included. Each species account takes up one page (two or more pages for some species that are variable and require extra information), with one or more photographs, a distribution map and text divided into three sections: habitat, descriptions and general. The photographs are excellent, and the distribution maps are clear (although

small) and of the 'solid' type (i.e. not actual 'point' occurrences).

The habitat and description sections are easy to read and interact well with the habitats chapter and the photographs and diagrams. The general sections contain good information on behaviour, sheltering, diet, reproduction and sizes (where these are known). The authors have provided significant new information for many species, e.g. the stalking behaviour of the Black-striped Snake (p174), and data on breeding for several species. Each genus is usually summarised in a text box with the first one or two species of that genus. These summaries are concise but not always sufficiently consistent in content to make comparisons easy (e.g. the number of species in each genus is not always given).

The family and higher groups accounts are good. There is one for frogs, but unfortunately not for reptiles. A few statements should have been better edited, e.g. p22 "[frog] species that excavate while moving forward" – the species in question burrow but do not excavate, and p57 " ... in reptiles the scales are the skin"" – this is too cryptic and needs more information to be clear in this sentence. The identification keys are easy to follow and provided only as needed for larger groupings (e.g. genera in a family, many species in one genus). Had the authors provided page numbers for each species' description in the key (after the species name) the keys would be even more user-friendly.

The seaturtles and seasnakes are not covered as comprehensively as other species, both groups (totalling nine species) being covered in seven pages (mostly of family type overviews). This short cut approach was apparently taken because the authors could not obtain photographs for, and field experience with, most of the marine species. This may disadvantage some students or naturalists who want information on the animals. The locality given for the photographed Yellow-bellied Sea Snake is incorrect: the specimen came from Sydney.

After the species accounts there are information-packed short chapters on commonly asked questions and human interactions with snakes (including snake bite and pets). One inaccuracy that biological editing should have removed is (p197) "Reptiles <u>are the only backboned animals that</u> continue to grow throughout their lives" – the underlined words should be deleted: some fish and amphibians do this also. The bibliography and references section are selective and for this popular book should have included the source for many of the core common names they adopted (e.g. Earless Skink, Cool Skink, Crevice Dragon, Ground Gecko) as well as other essential references in the scientific literature.

The glossary is comprehensive in content and concise in definitions: some of the morphological terms could have been linked to the diagrams in the book (i.e. head scales, frog morphology) with a 'see diagram page ...' after the definition. The index is limited mostly to names (common and scientific) but does include a few general entries, namely: fangs, freshwater turtles, habitats, keys, legless lizards, scientific names, skinks, tree frogs, but not other essentials (for this work) e.g. frogs, goannas, pythons or snake bite. While on snake bite, there are two separated and complimentary first aid outlines which should be combined so that there is *one comprehensive* emergency first aid procedure.

It is no wonder that this book is on the best seller list for non-fiction in Perth. It is a good regional guide with an eyecatching (too much so for the conservatives) cover, excellent layout, style , high quality photographs and good information. The critical comments that are made above are points for improvement for the next edition, of which there may well be several if the reputation of 'President Bush and his Men from the West' is anything to go by. These points in no way distract substantially from the overall value of the book. It is pleasing to see this regional guide which will do much to foster a stronger public interest in reptiles, frogs and their conservation in the Perth region and indeed, by induction, much of Western Australia. I recommend it for the library of every serious herpetologist and reptile keeper in Australia as well as other naturalists in south-western Western Australia.

Harald Ehmann

NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers.

Priority is given to articles reporting field work, observations in the field and captive husbandry/breeding.

All material must be original and must not have been published elsewhere.

PUBLICATION POLICY

Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonmic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25 mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

Latitude and longitude of any localities mentioned should be indicated.

Use the Concise Oxford Dictionary for spelling checks.

Photographs – black and white prints are preferred but colour slides are acceptable.

Use a recent issue of *Herpetofauna* as a stlye guide.

A computer disc may be submitted instead of a hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCI. Any disc must also be accompanied by hard copy.

Articles should not exceed 12 typed double spaced pages in length, including any illustrations.

REFERENCES

Any references made to other published material must be cited in the text, giving the author, year of publication and the age numbers if necessary. At the end of the article a full reference list should be given in alphabetical order. (See this journal).

Manuscripts will be reviewed by up to three referees and acceptance will be decided by an editorial committee. Minor changes suggested by the referees will be incorporated into the article and proofs sent to the senior author for approval.

Significant changes will require the article to be revised and a fresh manuscript submitted.

REPRINTS

The senior author will receive 25 reprints of the article free of charge.

Mary River turtle *(Elusor macrurus)*. See paper on page 46 (photo: D.Green).

Pindan Two-line dragon *(Diporiphora pindan)*. See paper on page 47 (photo: S. McAlpin).